Volume 22, Number 10, May 31, 1968

NUCLEAR SCIENCE ABSTRACTS

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Index References

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FOURRIER, Alain
  Radioactive chain of mass number 189,  21:10023
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Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

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MONTH, M.
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    form factors of the deuteron,  21:9744
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Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

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SHEEP
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    21:8560 (URS-658-3)
  fire resistance of components of, evaluation of,
    21:8789(R) (AD-642241)
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Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

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UNION CARBIDE CORP., OAK RIDGE, TENN.  Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
    storage containers,  21:8500 (Y-1561)
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Report Numbers

Technical report literature is also indexed by report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

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    2)
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                           1966)
  22298        21-9914   Nucl. News, 10: No. 1, 17-20(Jan.
                           1967)
  23267        21-9702   Phys. Rev., 152: 1171-82(Dec. 23,
                           1966)
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  23420        21-8764   Lancet, 2: 672-5(Sept. 24, 1966)
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Use of funds for printing this publication approved by the Director of the Bureau of the Budget, June 28, 1966.

Volume 22, Number 10 May 31, 1968

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 18737, 18776, 18811, 18859, 18908, 19270, 19351, and 20975.

18683 (AAEC/TM-87) METHODS FOR DETERMINING BERYLLIUM IN ENVIRONMENTAL MATERIALS. Cosgrove, J. D.; Morgan, Julie; Pakalns, P. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr. 1961. 14p. Dep.

Methods used at Lucas Heights for determination of beryllium in urine, milk, oyster shell, oyster flesh, grass, water, and soils are described. After suitable sample preparation beryllium is separated by an acetylacetone extraction, then determined fluorometrically with Morin. (auth)

18684 (AAEC/TM-394) AN IMPROVED METHOD FOR THE DETERMINATION OF ^{90}Sr IN OYSTER FLESH. Lahoud, A.; Piper, N. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1967. 17p. Dep.

The method used for determination of strontium-90 in environmental materials was subject to interference from the large concentration of zinc in oyster flesh. A suitable solvent extraction procedure was developed that will remove zinc without itself interfering in the determination. The method selected was the extraction of the thiocyanate complex of zinc from a hydrochloric acid solution into diethyl ether. This procedure removed more than 95% of the zinc and produced no undesirable complications. Normal recovery of strontium was raised to better than 90%. (auth)

18685 (AAEC/TM-395) AN IMPROVED METHOD FOR THE DETERMINATION OF ^{90}Sr IN SOILS AND SANDS. Lahoud, A.; Piper, N. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1967. 23p. Dep.

The method used for determination of ^{90}Sr in environmental materials was subject to interference from large concentrations of iron and aluminum in soil extracts. A suitable solvent extraction procedure was developed that will remove iron and aluminum without itself interfering in the determination. The method selected was the extraction of iron and aluminum acetylacetonates into chloroform at controlled values of pH. This procedure removed more than 95% of both iron and aluminum and produced no undesirable complications. Normal recovery of strontium was better than 80%. (auth)

18686 (BNWL-601) DETERMINATION OF MICROGRAM QUANTITIES OF FLUORIDE IN METAL OXIDES. Plucinski, C. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 12p. Dep. CFSTI.

A method for rapid and precise determination of fluoride in uranium and plutonium oxides was developed. The fluoride is separated from the oxide matrix by pyrohydrolysis and the amount measured with an electrode sensitive to fluoride ion activity. One to 100 ppM of fluoride can be determined in less than 15 min with a relative standard deviation of 3%. (auth)

18687 (EUR-3738) MISE AU POINT D'UNE METHODE RADIOMETRIQUE D'AUTOMATISATION DES ANALYSES DE PHOSPHATES ET DE SULFATES EN SOLUTION AQUEUSE. RAPPORT FINAL. (Development of a Radiometric Method for the Automatic Analysis of Phosphates and Sulphates in Aqueous Solution. Final Report). Bruna, A.; Caldera, P. G.; Tarditi, P. L. (Societa Ricerche Impianti Nucleari, Saluggia (Italy)). Feb. 1968. Contract 034-65-4 IRAI. 40p. (In French). Dep.

Two methods of determining sulfates and phosphates in aqueous solution using radioisotope-labeled reagents are described. The sulfates were assayed with ^{35}S in the presence of dioxan which reduced the solubility of the strontium sulfate in water; the phosphates were assayed with ammonium molybdate, then the phosphomolybdic complex was extracted by means of a mixture of organic compounds, using ^{32}P as labeled reagent. The use of labeled reagents permitted the automation of both analyses, and for this purpose two manually controlled semi-automatic rigs were developed, by which sulfates and phosphates can be analyzed in about ten to fifteen minutes. Results of analyses performed with these rigs on sulfate and phosphate samples with various concentrations ranging from a few ppM to several thousand are reported. The results were satisfactory: the analyses were of high precision and sensitivity, the precision margin being about ±1%. Two examples of the application of the developed methods to two industrial analyses are also described, namely the determination of phosphates in phosphate fertilizers, and the determination of sulfates in the brine used in mercury-cathode electrolysis cells for the production of chlorine and soda. (auth)

18688 (HNS-1229-57) RADIOACTIVE XENON ANALYTICAL FACILITY. Schell, W. R.; Carnahan, C. L. (Hazleton-Nuclear Science Corp., Palo Alto, Calif.). Jan. 26, 1965. Contract AT(29-2)-1229. 30p. Dep. CFSTI.

An analytical facility for measuring radioactive xenon in air samples was set up. The facility consists of a gas-separation system, which effectively removes air, krypton, and radon from xenon, and a low-level gas counting system. The xenon activity is measured in low-level, internally filled detectors. The gas-separation method employed is based on an earlier design by Momyer, in which an air sample is condensed on liquid-nitrogen-cooled charcoal traps, and then selectively eluted during warming while helium carrier gas is passed through the traps. A gas chromatography preparative column filled with molecular sieve is used in the final purification step. The elution progress is determined by two thermal conductivity cells. Recovery of xenon from ~100 S.C.F. of air sample is better than 94%, and effective decontamination from krypton and radon is achieved. Decay characteristics of ^{131m}Xe, ^{133}Xe, ^{133m}Xe, and ^{135}Xe are discussed with reference to ^{133}Xe measurement in internally filled detectors. Eight 56-cm^3 detectors were designed to enable xenon to be condensed in a cold finger, and methane counting gas to be added to one atmosphere total pressure. The detectors were inserted between two lead shielded guard detectors, which were designed for anticoincidence planchette counting. The detectors have anticoincidence backgrounds of from 2.5 to 4.2 cpm and efficiencies for ^{133}Xe of 70 to 82%. The facility is capable of analyzing one 100 S.C.F. air sample in nine hours, and each sequential sample in an additional five hours. (auth)

18689 (K-1697) TRIPLE POINT DEPRESSION CURVES FOR THE BINARY SYSTEMS TUNGSTEN HEXAFLUORIDE IN URANIUM HEXAFLUORIDE AND MOLYBDENUM HEXAFLUORIDE IN URANIUM HEXAFLUORIDE: THEIR APPLICATION TO METHODS OF ANALYSES. Hedge, W. D. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Mar. 22, 1968. Contract W-7405-eng-26. 20p. Dep. CFSTI.

The triple point depression curves for the binary systems tungsten hexafluoride–uranium hexafluoride and molybdenum

hexafluoride–uranium hexafluoride were determined over the range of 100.0 to 98.5 mole percent uranium hexafluoride. The observed data are represented by the following general equations obtained by the least squares method: WF_6-UF_6, $N_2 = (\Delta t) \exp [-4.2114 + 0.2001(R)]$ and MoF_6-UF_6, $N_2 = (\Delta t) \exp [-4.0357 + 0.0252(R)]$ where N_2 is the mole fraction of solute, (Δt) is the triple point depression in °C, and R is the ratio of liquid volume to total volume. The deviations resulting from non-ideality are discussed. Corrections for these deviations are applied by extrapolation of observed triple point depressions and ratios of liquid volume to total volume. A method is presented to estimate the liquid, gross, and vapor compositions. (auth)

18690 (K–1698) MOLYBDENUM HEXAFLUORIDE–HYDROGEN FLUORIDE TRIPLE POINT CURVE AND ITS APPLICATION TO A METHOD OF ANALYSIS. Hedge, W. D. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Mar. 22, 1968. Contract W-7405-eng-26. 22p. Dep. CFSTI.

The triple point curve for the binary system molybdenum hexafluoride–hydrogen fluoride was determined over the range of 0.0 to 5.0 mole percent hydrogen fluoride. This system is represented by the following general equation: $\Delta t = A(N_2) + B(N_2)^2 + C(N_2)^3$, where Δt is the depression of the triple point of pure molybdenum hexafluoride in degrees centigrade, N_2 is the mole fraction of hydrogen fluoride, and A, B, and C are constants with $A = 159.86 - 129.19(R) + 36.44(R)^2$, $B = -3624.5 + 2965.0(R) - 407.5(R)^2$, and $C = 26239.0 - 17875.0(R) - 1796.2(R)^2$. R is the ratio of liquid volume to total volume. The deviations resulting from non-ideality are discussed. Corrections for these deviations are applied by extrapolation of observed triple point depressions and ratios of liquid volume to total volume as represented by the above general equation. A method is also presented to estimate the liquid, gross, and vapor compositions. (auth)

18691 (KN–68–71(R)) SOME PRINCIPLES OF ACTIVATION ANALYSIS. Wood, D. E. (Kaman Nuclear, Colorado Springs, Colo.). Feb, 1968. 72p. (CONF-670727–1). Dep.

From Conference on Neutron Activation Analysis in Industry, Houghton, Mich.

An introduction to the principles of activation analysis is given. Neutron sources, instrumentation, radiation problems, typical systems, and some applications are discussed with emphasis on the fairly simple applications that lead to fully automatic systems for industrial purposes. Systems based on neutron generators, rather than reactors, are considered because of the wide potential use of these systems in production and quality control areas, as well as general analytical laboratories. (auth)

18692 (KR–120) DETERMINATION OF SOME LANTHANIDE ELEMENTS IN APATITES BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS. Steinnes, E. (Institutt for Atomenergi, Kjeller (Norway)). Oct. 1967. 2p3p. Dep.

The content of lanthanum, samarium, europium, and dysprosium in six apatites of various localities was determined by neutron activation and gamma spectrometry. The gamma activity measurements were performed by means of a sodium iodide detector, and were based on the complex x-ray peak at about 40 keV for Sm, Eu, and Dy, and on the 1590-keV photopeak for La. The results obtained are probably accurate to ±10% or better. In some of the samples the relative abundance of europium compared to that of the other lanthanides appears to be significantly low. (auth)

18693 (LA–3876) INVESTIGATION OF TWO METHODS FOR MEASURING FREE ACID IN PLUTONIUM SOLUTIONS. Dahlby, J. W.; Waterbury, G. R.; Metz, C. F. (Los Alamos Scientific Lab., N. Mex.). Dec. 1, 1967. Contract W-7405-eng-36. 8p. Dep. CFSTI.

The reliabilities of two methods for measuring free acid in plutonium solutions were determined by applying each to the analysis of plutonium, thorium, and cerium solutions having known free acid concentration. In the iodate method, the hydrolyzable ion was precipitated with iodate and separated by filtration, and the free acid in the filtrate was titrated with standard base. In the citrate method, the hydrolyzable ion was complexed with citrate during the titration of the free acid with standard base. Between 99 and 100% of the free acid in plutonium(IV) solutions was measured using the iodate method, and high results, 106 to 109%, were obtained using the citrate method. Neither was reliable for determining free acid in plutonium(III) solutions; the iodate method gave low results (94 to 96%), and the citrate method gave high results (108 to 109%). (auth)

18694 (TID–23668) NEUTRON ACTIVATION TECHNIQUES FOR MINERAL EXPLORATION. Annual Report. Senftle, F.; Hoyte, A.; Martinez, P.; Mitchell, C. (Geological Survey, Washington, D. C.). Aug. 31, 1966. Contract AT(49-11)-2784. 51p. Dep. CFSTI.

This report is divided into two sections, a feasibility study of neutron activation as a mineral exploration tool, and the application of neutron activation analysis specifically to the problem of silver exploration. (auth)

18695 (UCRL–50383) DETERMINATION OF RARE EARTHS AND FLUORIDES IN RARE EARTH FLUORIDES. Rigdon, L. P.; Sunderland, W. E. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 31, 1968. Contract W-7405-eng-48. 10p. Dep. CFSTI.

A technique was developed for assaying rare earths and fluorides in refractory rare earth fluoride samples. For fluoride determination, a portion of the sample is fused with NaOH in a platinum crucible and the melt is dissolved in water. The solution is transferred to a cation exchange column in the hydrogen form, the fluoride is eluted as HF with water, and the fluoride determination is made indirectly by titration of the HF with standard NaOH. For rare earth determination, a separate portion of sample is fused with potassium pyrosulfate and dissolved in water; the determination is made by titration with EDTA. Recommended procedures for both constituents and data from the analysis of 14 samples are presented. The relative standard deviation is 0.6% for fluorides and 0.4% for rare earths. (auth)

18696 (CONF–651090–1) USE OF γ-EXCITED X-RAY LUMINESCENCE TO DETERMINE LEAD CONTENT IN MULTIMETAL ORES. Shmonin, L. I.; Enker, M. B.; Mager, E. V.; Ostapenko, V. F. Translated by J. E. Baker for Atomic Energy Research Establishment, Harwell, Eng.), from Nekot. Vop. Obshch. Prikl. Fiz., Tr. Gor. Konf., Alma-Ata, 1965, 173-5(1966). 8p. Dep. CFSTI. UK. JCL $1.10 fs, $0.80 mf.

The possibility of devising a method using gamma-excited x-ray luminescence for determining the lead content of ores with considerable admixtures of barium was studied. Selenium-75 was used as the gamma source. A method using two spectral ratios gave a sensitivity of approximately 0.2% lead. (M.C.G.)

18697 NATURAL RADIOACTIVITY OF SOIL AND PLANTS. Benes, Jaroslav (Inst. of Nuclear Research, Prague). Jad. Energ., 14: 100-4(Mar. 1968). (In Czech).

Dosimetric criteria and methods for isolating radioisotopes are discussed. Measurements were made of γ radiation from ^{40}K in order to determine the amount of potassium in soils, plants, and commercial fertilizers. (R.V.J.)

18698 RADIOACTIVE KRYPTONATES IN VOLUMETRIC ANALYSIS. I. RADIOACTIVE KRYPTONATES: NEW CHELATOMETRIC INDICATORS. Tolgyessy, J.; Varga, S.; Jesenak, V.; Hroncova, D. (Slovak Technical Univ., Bratislava). Chem. Zvesti, 22: 3-14(1968).

A method using radioactive kryptonates as end-point indicators in chelatometric titrations was developed. The end-point is determined with the help of solid radioactive kryptonate AB[^{85}Kr], added into the tested solution before the beginning of titration. After exceeding the end-point, the excess of the added chelate-forming agent reacts with radioactive kryptonate liberating radioactive krypton ^{85}Kr. Principles of the titration method, methods for preparing radioactive kryptonated indicators, experimental results of kryptonation and a study of the properties of prepared radioactive kryptonates from the point of view of their application as indicators in radiochelatometric titrations are given. (auth)

18699 DETERMINATION OF HAFNIUM IN ZIRCALOY SAMPLES BY ISOTOPE DILUTION. Tamura, Shuzo; Gunji, Katsuumi; Toida, Kimiko (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 17: 82-5(Jan. 1968). (In Japanese).

The stable isotope dilution technique has been applied to the determination of hafnium in some of the samples of Zircaloy. Hafnium in the sample was separated by anion exchange chromatography eluted with dilute sulfuric acid. A surface ionization type mass spectrometer (CEC 21–702B) was used with tungsten ribbon triple filaments for hafnium isotope analysis. Hafnium is determined within a relative error of several percent in the range from 40 to 500 ppM. The results obtained are discussed in comparison with those measured by other methods. (auth)

18700 PHOTOMETRIC DETERMINATION OF ALUMINUM IN FERRO-ALLOYS WITH STILBAZO. Maekawa, Shizuya; Kato, Kiyotoshi (Japan Steel Works Co., Ltd., Hokkaido, Japan). Bunseki Kagaku, 17: 70-5(Jan. 1968). (In Japanese).

The photometric determination of 0.01 to about 5 percent of aluminum in ferrovanadium, ferrotitanium, ferrozirconium, and ferroniobium with stilbazo has been studied. The aluminum-stilbazo complex showed an absorption maximum at 495mμ with constant absorbance at pH range from 4.3 to 6.0, and Beer's

law was obeyed up to 50μg of aluminum when 2.5 ml of stilbazo solution (0.08 wt/vol %) was used. The established method is as follows. In cases of ferrovanadium and ferrotitanium, 0.1 to 0.5g of sample is decomposed by treating with hydrochloric-nitric acid. In cases of ferrozirconium and ferroniobium, samples are decomposed by treating with nitric–hydrofluoric acid, and is evaporated with sulfuric acid to strong fumes until hydrofluoric acid has been removed. After being cooled, the interfering vanadium, titanium, zirconium, niobium, and iron are removed by extraction with cupferron–chloroform in the presence of 3.5 N hydrochloric acid. The acidity of the solution is adjusted to pH about 5 with ammonia water (1 + 1) and hydrochloric acid (1 + 1) using p-nitrophenol as an indicator. One ml of ascorbic acid solution (5 wt/vol %) 10 ml of the buffer solution (pH 5.60) and 2.5 ml of stilbazo solution (0.08 wt/vol %) are added, and the mixture is made up exactly to 50 ml with water. The absorbance is measured at 495mμ against reagent blank. The time required for an analysis is about 50 minutes. (auth)

18701 SPECTROPHOTOMETRIC DETERMINATION OF ALUMINUM WITH CHROMAZUROL S AND CETYL TRIMETHYLAMMONIUM CHLORIDE. Shijo, Yoshio (Univ., Utsunomiya, Japan); Takeuchi, Tsugio. Bunseki Kagaku, 17: 61-5(Jan. 1968). (In Japanese).

Chrome Azurol S reacts with Al in the presence of hexadecyltrimethylammonium chloride to form a blue ternary chelate. Its absorption maximum varies continuously with pH and reagent concentration, but absorbance at 620mμ is constant at pH 5.8 ~ 6.0 and obeys Beer's law over 0.01 ~ 0.08μg Al/ml. The sensitivity is very high since the molar extinction coefficient is 1.08×10^5. Be, Ga, Ti, Th, U, V, Zr, Cu, Fe, Cr, Sn, and Ta interfere remarkably, but Cu and Fe(II) can be masked by o-phenanthroline. (auth)

18702 RAPID DETERMINATION OF URANIUM IN GEOCHEMICAL SAMPLES BY PAPER CHROMATOGRAPHY. Plamondon, J. (Dept. of Natural Resources, Quebec). Econ. Geol., 63: 76-9(Jan.-Feb. 1968).

Concentrations of uranium as low as 1 ppM are determined in soils and sediments by ascending paper chromatography, subsequently to a hot nitric acid attack of the samples. The reagent 1-(2-pyridylazo)-2-naphthol (PAN), which is used to develop the chromatograms, is capable of detecting 0.05γ of uranium. The method is rapid and inexpensive. (auth)

18703 METHODS FOR TRACE ANALYSIS OF RARE EARTHS. Cosgrove, J. F.; Oblas, D. W.; Walters, R. M.; Bracco, D. J. (General Telephone and Electronics Labs., Inc., Bayside, N. Y.). Electrochem. Technol., 6: 137-41(Mar.-Apr. 1968).

The emergence of rare earth-activated materials in luminescence and laser applications has posed new demands on methods of detection of rare earths at trace levels. Several instrumental methods applied to rare earth-activated phosphors and the raw materials used in their synthesis were evaluated. Emphasis is on the effectiveness of comprehensive analysis at trace levels. The results include determinations made possible by recent innovations in the techniques of mass spectroscopy, emission spectroscopy, activation analysis, and optical fluorescence excited by x rays. (auth)

18704 REACTION GAMMAS FOR ANALYSIS OF IMPURITIES IN α EMITTERS. McKibben, J. Malvyn (E. I. duPont de Nemours and Co., Aiken, S. C.). Nucl. Appl., 4: 260-7(Apr. 1968).

Certain light elements that undergo nuclear reactions with alpha particles can be identified in alpha emitters such as $^{238}PuO_2$ by analysis of the resulting radiation—specifically, of gamma photons, or "reaction gammas." Gamma spectrometry has been successfully used for this purpose on production lots of $^{238}PuO_2$ from which neutron emission rates were abnormally high because of (α,n) reactions with impurities. To establish a base for this type of analysis, reaction gamma spectra for 14 light elements were obtained by measuring gamma spectra from samples of $^{238}PuO_2$ before and after addition of known quantities of the elements. Emission rates of major gammas of each element, in γ/min per gram of ^{238}Pu, were also developed from these standard mixtures. A catalog of principal reaction gammas from each element was assembled. Although absolute emission rates of reaction gammas were obtained, this technique is only semiquantitative because the gamma yield is highly dependent on a number of variables, including the incident alpha energy and the distribution of the impurity element in the sample. (auth)

18705 REVIEW OF RECENT STUDIES OF NONDESTRUCTIVE ASSAY METHODS FOR IRRADIATED NUCLEAR FUELS. Edwards, Raymond R. (Carnegie-Mellon Univ., Pittsburgh). Nucl. Appl., 4: 245-59(Apr. 1968).

Implementation of safeguards against diversion of special nuclear materials from peaceful uses to weapons often requires nondestructive assay of fuel materials at various stages in the fuel cycle to obtain information on fissile material burnup, detailed fuel history, and content of ^{235}U, ^{239}Pu, and ^{233}U. Past, current, and proposed efforts to elicit the required information included direct gamma spectrometry of fuel materials (by means of scintillation and, more recently, solid-state detectors); indirect gamma spectrometry (magnetic analysis of external conversion electron spectra, Compton spectrometry by semiconductor detection pulse-height analysis); x-ray emission spectrometry; activation analysis of stable (or very long-lived) fission products; use of external monitors for neutron flux and/or fission and breeding rates; fast/slow neutron-fission counters; neutron transmission measurements; fission neutron counting and spectrometry (prompt and delayed); photonuclear response measurements; and calorimetry. The various methods are described and compared for accuracy and precision, for the kind of information elicited, and for probable cost and portability of equipment required. (auth)

18706 HAFNIUM DETERMINATION IN THE PRESENCE OF LARGE AMOUNTS OF MOLYBDENUM. Shakhova, Z. F.; Semenovskaya, E. N.; Sokovikova, N. K.; Koval'chuk, V. A. Vestn. Mosk. Univ., Ser. II. Khim., No. 1, 121-3(Jan.-Feb. 1968). (In Russian).

The possibility of photometric determination of small amounts of Hf using Arsenazo-III without preliminary separation of molybdenum is shown. A method for determination of hafnium and molybdenum present together by aluminum hydroxide as a collector is suggested. (auth)

18707 GRAVIMETRIC DETERMINATION OF CAESIUM AND POTASSIUM WITH SODIUM TRIPHENYLCYANOBORATE (CAESIGNOST). Bauman, Alica (Inst. for Medical Research, Zagreb). Talanta, 15: 185-8(Feb. 1968).

Cesium can be determined gravimetrically with sodium triphenylcyanoborate (Caesignost) as precipitant. The precipitation was checked by addition of ^{137}Cs tracer and gamma spectrometry. The following parameters were studied: temperature, digestion time, influence of potassium on the precipitation of cesium, and separation of cesium from bulk quantities of potassium. (auth) (UK)

18708 QUANTITATIVE ANALYSIS OF MIXTURES OF METAL IONS BY THE RING-OVEN METHOD: URANIUM–THORIUM–ZIRCONIUM–TITANIUM AND THORIUM–CERIUM–ZIRCONIUM–TITANIUM. Ghose, Animesh K.; Dey, Arun K. (Univ. of Allahabad, India). Separ. Sci., 2: 665-71(Nov. 1967).

Successful schemes for the separation of the constituents in the mixtures U–Th–Zr–Ti and Ce–Th–Zr–Ti were worked out, using the ring-oven method. The constituents were first separated in the form of thin rings. The rings were then developed with selective organic reagents. For the determinations, the intensities of these rings were then compared visually with standard rings, similarly prepared with known amounts. The time required for complete separation and determination of the constituents was about 60 to 70 min, excluding the time required for the preparation of the standard scales. Separations are possible down to the following concentrations: Ce, 2.1 μg; Th, 3.5 μg; Ti, 0.36 μg; U, 1.8 μg; and Zr, 2.7 μg. (auth)

18709 TRITIUM DETECTION BY β-RADIOLUMINESCENCE IN STANDARD MEDIA FOR THIN-LAYER CHROMATOGRAPHY. Prydz, Svein; Skammelsrud, Kare S. (Univ. of Oslo). J. Chromatogr., 32: 732-6(Feb. 20, 1968).

The relative β-scintillation efficiencies of several thin-layer media for chromatography ("Merck" alumina and silica) were determined at room and lower temperatures. In addition, the spectral composition of the emitted luminescence (for the most efficient media) was investigated to obtain a basis for choosing photomultiplier or film material with appropriate spectral response for optical detection. A broad-band emission (500 to 700 nm) was found, where a dominant peak at about 650 nm was due to gypsum admixture (as a binder). The sensitivity for tritium detection by luminescence was estimated. (auth)

18710 RESEARCH WITH THE ISOTOPES OF OXYGEN (^{15}O, ^{17}O, AND ^{18}O) DURING 1963–1966. Samuel, D.; Steckel, F. (Weizmann Inst. of Science, Rehovoth, Israel). Int. J. Appl. Radiat. Isotop., 19: 175-217(Mar. 1968).

References (789) are given to journals, books, patents, and theses published from 1963 through 1966. A few papers published before 1963, not listed in the original bibliography or in the supplements, have also been added. Separate subject and author indexes are included. (P.C.H.)

18711 DETERMINATION OF THOROTRAST IN TISSUE SAMPLES BY NEUTRON ACTIVATION ANALYSIS. Scheer, K. E.; Krauss, O.; Varga, L. (Institut fuer Nuklearmedizin, Heidelberg). Atompraxis, 13: 451-3(Oct. 1967). (In German).

A process for determination of thorium in tissue samples by neutron activation analysis in a reactor is described. The process is easy to carry out and suitable for serial tests, as no preparations of the irradiated tissue samples are necessary before the test. The most favorable conditions are achieved by measuring the γ lines between 300 and 341 keV of ^{233}Pa, formed by the decay of ^{233}Th. An irradiation of the samples of four hours, with a neutron flux of 2×10^{12} n/cm^2 · s gives a very good sensitivity of detection and is easy to carry out in the roundabout of the TRIGA reactor. The best time for measuring is at about 400 hr after the activation. This makes it possible to send the samples for activation even to distant reactor stations. The sensitivity of detection is of 20×10^{-9} g thorium for 1 g of tissue. (auth)

18712 METHOD FOR THE QUANTITATIVE EVALUATION OF RADIOPAPERCHROMATOGRAMS OF TRITIUM-LABELED COMPOUNDS BY VIAL COMBUSTION OF STRIPS. Schaumloeffel, E.; Belzer, H.; Graul, E. H. (Philipps Univ., Marburg, Ger.). Atompraxis, 13: 448-51(Oct. 1967). (In German).

In connection with results of investigations regarding quantitative radio paper chromatography of ^{3}H-labeled compounds, a method is described for the in-vial combustion of chromatographic paper strips and determination of the activity by liquid scintillation counting. (auth)

18713 QUANTITATIVE ELECTRON PROBE MICROANALYSIS: ABSORPTION CORRECTION UNCERTAINTY. Yakowitz, H.; Heinrich, K. F. J. (National Bureau of Standards, Washington, D. C.). Mikrochim. Acta, No. 1, 182-200(1968).

The accuracy of the x-ray absorption correction for quantitative microprobe analysis was found to be affected by uncertainties in the input parameters (mass attenuation coefficients, x-ray emergence angle, and operating voltage), as well as by inaccuracies in the proposed absorption correction models. If the mass attenuation coefficient is known within 5%, then to keep the error of this correction below 1%, the absorption function, f(χ), must be equal to or higher than 0.8. Experimental conditions leading to small absorption corrections are discussed, and the advantages of high x-ray emergence angles are demonstrated. As an illustration, the analysis, theoretical and experimental, of several aluminum–magnesium alloys is discussed. (auth)

18714 SPOT TEST FOR MOLYBDENUM THROUGH EXTRACTION OF ITS O-PHENANTHROLINE–THIOCYANATE COMPLEX. Rao, V. Pandu Ranga; Rao, K. Venugopala; Sarma, P. V. R. Bhaskara (Andhra Univ., Waltair, India). Mikrochim. Acta, No. 1, 89-91(1968).

Molybdenum(VI) reacts with o-phenanthroline and thiocyanate in presence of chlorostannous acid to give a pink complex which can be extracted into benzyl alcohol. As little as 0.025 μg of molybdenum in 0.5 ml solution can be detected by this method. Many colored ions and complexing agents are without any effect on this detection test. (auth)

18715 DETERMINATION OF MOLYBDENUM IN IRON AND STEEL WITH A VACUUM SPECTROMETER. Goto, Hidehiro; Saito, Akira (Tohoku Univ., Sendai). Bunseki Kagaku, 17: 194-9(Feb. 1968). (In Japanese).

In the direct-reading spectrometric determination of molybdenum, analytical results are often interfered from the overlapping spectral lines of nickel and manganese. New analytical lines of molybdenum, Mo II 2038.46 Å and Mo II 2020.32 Å, are proposed in the wavelength range of 2200 Å to 1780 Å. The line Fe II 1761.38 Å was used as an internal standard. Using these spectral lines, interfering elements, excitation conditions, and reproducibility of the results were investigated. The best results were obtained under the excitation by a spark of the critically damped discharge of a low voltage condensor. Mo II 2038.46 Å is slightly interfered from the overlapping line of manganese. With Mo II 2020.32 Å, which had no interfering element, however, 0.20 and 1.09% of molybdenum in low alloy steels were determined with the variation coefficients of 2.2 and 1.6%, respectively. (auth)

18716 STYLOMETRIC DETERMINATION OF RARE EARTH ELEMENTS IN SOLUTIONS. Zakhariya, N. F.; Karpenko, L. I.; Fadeeva, L. A. Zh. Prikl. Spektrosk., 7: 795-7(Nov. 1967). (In Russian).

The possibility of using the stylometric analysis for accelerated control of separation processes of rare earth elements was shown. The method for the determination of Y, Gd, Dy, and La with a sensitivity of 0.1 mg/ml for Y and La and 0.5 to 1.0 mg/ml for Gd and Dy was described. (tr-auth)

18717 SPECTROPHOTOMETRIC DETERMINATION OF MOLYBDENUM(VI) BY EXTRACTION OF MOLYBDENUM(VI)-ALIZARIN RED S COMPLEX WITH QUATERNARY AMMONIUM CHLORIDE. Ishibashi, Nobuhiko; Kohara, Hitoshi; Abe, Kiyomi (Kyushu Univ., Fukuoka). Bunseki Kagaku, 17: 154-60(Feb. 1968). (In Japanese).

The extraction of molybdenum(VI)–Alizarin Red S complex with quaternary ammonium chloride has been investigated for the determination of molybdenum-(VI). The complex extracted into 1,2-dichloroethane has an absorption maximum at 525 mμ, with a constant absorbance in the pH range from 4.5 to 5.5. The molar ratio of molybdenum(VI) to Alizarin Red S in the complex is estimated to be 1 to 2 for aqueous phase, and 1 to 3 for organic phase. By extracting the complex into organic phase with tetradecyl-dimethylbenzyl ammonium chloride, the sensitivity increases about three times as much as that of aqueous phase. For the absorbance of complex in analytical condition, Beer's law is obeyed at least up to 2.5×10^{-6} M molybdenum(VI) in 1,2-dichloroethane. The effect of diverse ions was also examined. (auth)

18718 NEUTRON ACTIVATION DETERMINATION OF GOLD IN IRON METEORITES AND INCLUSIONS. Linn, T. A. Jr.; Moore, C. B. (Arizona State Univ., Tempe). Earth Planet. Sci. Lett., 3: 453-6(Feb. 1968).

The concentrations of gold in 19 iron meteorites have been determined via instrumental neutron activation analysis. The upper limits of gold concentrations in 10 sulfide nodules and in one phosphide inclusion were also established. Gold concentrations ranged from 0.2 ppM to just over 2 ppM in the metal. The sulfide nodules and phosphide inclusions showed limiting concentrations of about 0.1 ppM gold. (auth)

18719 OSCILLOPOLAROGRAPHIC DETERMINATION OF SAMARIUM IN ADDITION TO OTHER ELEMENTS OF THE RARE EARTHS. Sykut, Kazimierz. Ann. Univ. Mariae Curie-Sklodowska, Lublin-Pol., Sect. AA, 20: 1-25(1965). (In Polish).

As a result of studies made on the oscillopolarographic behavior of Sm and Yb, a method was developed for the determination of Sm, Eu, and Yb in the presence of other lanthanides. This method made it possible to detect contents of 2×10^{-9} m/l of Sm. The flowing mercury electrode, used for determination of Sm in amalgams at concentrations from 6×10^{-4} to 1×10^{-2}% is described in detail. The course of the process was examined and the conditions for determination are given. The F = f(i) curves were obtained and the possibilities for their use were discussed. (tr-auth)

18720 FRACTIONATED PRECIPITATION OF BASIC NITRATES OF THE RARE EARTHS. Hubicki, Wlodzimierz; Brandel, Boleslaw; Stodolkiewicz, Lech. Ann. Univ. Mariae Curie-Sklodowska, Lublin-Pol., Sect. AA, 20: 77-85(1965). (In German).

Results of the separation of 40 kg of the cerium group by fractional precipitation of basic nitrates of the rare earths are reported. At temperatures from 90 to 100°C precipitation by gaseous air-borne ammonia in the presence of 2 to 3N NH_4NO_3 led to the production of easily filtered oxides. From solutions of rare earth oxides with a concentration of 40 g of Ln_2O_3 in 1 liter (composition of Ln_2O_3 is 4.6% Sm_2O_3, 37.5% Nd_2O_3, and the rest La_2O_3) at acidities up to pH 7.6, practically all the Sm is precipitated, whereas at pH 7.6 to 7.8 the fraction contains concentrations of Nd–Pr, and at pH 7.8 to 8.0, La–Nd–Pr is obtained. At pH above 8.0 lanthanides of satisfactory purity are obtained. (tr-auth)

18721 ISOTOPIC ANALYSIS OF RARE GASES IN A TELLURIUM ORE OF BOLIDEN, SWEDEN. Kirsten, T.; Gentner, W.; Mueller, O. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Naturforsch., 22A: 1783-92(Nov. 1967). (In German).

The stable He, Ne, Ar, Kr, and Xe isotopes and the Te, K, U, Th and Se concentrations in a Precambrian bismuth–tellurium ore were measured. Ages of 0.53×10^9 yr with K–Ar, 0.55×10^9 yr with U/Th–^{4}He, and 1.56×10^9 yr by the U–^{136}Xe method were found. The ^{131}Xe excess and part of the ^{129}Xe excess resulted from n capture and subsequent decay of ^{128}Te and ^{130}Te. The remaining part of the ^{129}Xe excess and the high U–^{136}Xe age gave evidence for a higher neutron flux before the last cooling of the ore. The tellurium was probably associated previously with much more uranium. Before 0.54×10^9 yr, differentiation of this uranium occurred. Moreover, He and Ar but not all of the Xe were removed at this time. After cooling, the ^{129}Xe excess was formed by the decay of the long-lived ^{129}I that was formed from (n,γ) reactions on ^{128}Te by the higher neutron flux. From the excess in ^{130}Xe, a half-life for the double β-decay of ^{130}Te of 6.2×10^{20} yr was calculated. Besides fission–Kr, there was an excess of Kr with atmospheric composition and in addition an excess of ^{82}Kr and ^{83}Kr also. From the ^{82}Kr-excess and the

selenium content a lower limit for the ^{82}Se double β-decay half-life of $T_{\frac{1}{2}} \geq 10^{18}$ yr was calculated. No evidence is given for ^{38}Ar from U-fission. (auth)

18722 STUDIES OF LIQUID RADIOACTIVE EFFLUENT DISCHARGED TO THE AQUATIC ENVIRONMENT FROM C.E.G.B. NUCLEAR POWER STATIONS: A SEQUENTIAL SCHEME FOR THE ANALYSIS OF MAJOR METALLIC RADIOISOTOPES. Dutton, J. W. R.; Harvey, B. R. (Fisheries Radiobiological Lab., Lowestoft, Eng.). Water Res., 1: 743-57(Nov.-Dec. 1967).

In the scheme described radioantimony was first precipitated as the sulphide, and radioisotopes of manganese, zirconium, cobalt, niobium, iron, and zinc were then separated individually using an anion exchange column in the chloride form. Caesium was removed by adsorption on zirconium phosphate, and finally chromium and cerium were obtained as separate fractions using an anion exchange column in the nitrate form. Simple one- or two-gate gamma-counting, using a sodium iodide crystal, was used to assay between 10 and 12 gamma-emitting isotopes; ^{55}Fe was measured by gel-scintillation or proportional counting. (auth) (UK)

18723 CARTRIDGE-TYPE VACUUM LOCK FOR A THERMAL-IONIZATION MASS SPECTROMETER. RAPID DETERMINATION OF RELATIVE ISOTOPIC RATIOS OF POTASSIUM. Howard, Olin H.; Langdon, Aubrey; Sulfridge, Clint (Union Carbide Corp., Oak Ridge, Tenn.). Anal. Chem., 40: 643-5(Mar. 1968).

Work was carried out on the rapid determination of relative isotopic ratios of potassium altered in an experimental system. A double-filament thermal-ionization source and a cartridge-type vacuum lock were developed for a 60° magnetic, 6-in. radius mass spectrometer. Potassium metal is converted to the iodide and vaporized from a sample filament. Potassium ions are generated when the vapor contacts a hotter, ionizing filament. The ions are accelerated by 3000 V through a beam-defining slit and through the magnetic analyzer. The $^{41}K^+$ and $^{39}K^+$ ion currents are detected simultaneously on separate collectors, amplified, and fed to a ratio recorder whose output is proportional to the $^{41}K/^{39}K$ ratio. Standard deviations of 0.0018 and 0.0024 were obtained at $^{41}K/^{39}K$ relative ratios of 1.0060 and 1.5366, respectively. (M.C.G.)

18724 GRAPHICAL TECHNIQUE FOR ESTIMATING ACTIVITY LEVELS PRODUCED IN THERMAL- AND FISSION-NEUTRON IRRADIATION. Routti, Jorma T. (Univ. of California, Berkeley). Anal. Chem., 40: 593-602(Mar. 1968).

A rapid and flexible graphical method for estimating the activity induced in neutron irradiations is described. The method, applicable to several activation problems, was applied to thermal- and fission-neutron irradiations, which are widely used in activation analysis with reactors. The calculated saturation activities of the products of most activation reactions are represented on two activation charts. A graphical technique, using a transparent overlay, to obtain corrections for the saturation, decay, and counting factors was developed. The principal advantage of the method is that the corrections due to these factors can be applied to any saturation activity of the chart, which already contains all the nuclear information required for estimation of induced radioactivity. Most simple activity calculations can be performed quickly and accurately; the technique is also useful in estimating the best irradiation and decay times to enhance selected activities in composite samples. The numerical values for the construction of charts of saturation activities for thermal- and fission-neutron irradiation and for the overlay are given. Calculation techniques are explained and clarified with typical examples. (auth)

18725 SPECIFIC ULTRAVIOLET SPECTROPHOTOMETRIC DETERMINATION OF EUROPIUM OXIDE AS A COMPLEX IN MIXTURES OF RARE EARTH OXIDES. Pobiner, Harvey (American Can Co., Princeton, N. J.). Anal. Chem., 40: 564-7 (Mar. 1968).

An analytical method for europium oxide is described. Of the 17 rare earth oxides, including scandium, yttrium, and thorium, only europium reacts with certain dipolar, aprotic solvents, such as dimethylformamide in hydrochloric acid solution, to produce a measurable ultraviolet absorption spectrum. A charge-transfer mechanism is indicated. The specificity of this reaction serves as a quantitative measure of the europium oxide and is useful for determining europium oxide in mixtures of rare earth oxides. The complex is stable at pH levels of 1 to 2, but undergoes an alkaline decomposition that can be followed by ultraviolet spectrophotometry and turbidimetry. The analytical method was subsequently developed into a potential process for the recovery of europium oxide from mixtures of rare earth oxides and from certain phosphors. (auth)

18726 REACTION OF THORIUM CHLORANILATE WITH FLUORIDE. West, C. David; Birke, Ronald L.; Hume, David N. (Massachusetts Inst. of Tech., Cambridge). Anal. Chem., 40: 556-60(Mar. 1968).

The reaction between thorium chloranilate and fluoride ions in aqueous pH 4.7 buffer under analytical conditions yielded one chloranilate anion in solution for each two fluoride ions, and thorium difluorochloranilate as a solid phase. In 1:1 methyl Cellosolve–water medium, the same reaction took place but the colored thorium difluorochloranilate was soluble, enhancing the sensitivity. Larger amounts of fluoride led to the formation of insoluble thorium fluoride. (auth)

18727 SPECTRAL ANALYSIS OF IMPURITIES IN SCANDIUM AND ITS COMPOUNDS. Degtyareva, O. F.; Permyakova, T. A. Zh. Prikl. Spektrosk., 7: 594-8(Oct. 1967). (In Russian).

A method for the quantitative spectral analysis of impurities in Sc, based on the fractional distillation of the impurities in the ac arc, was developed. Metallic Sc is converted into the oxide and the spectrum is excited with carbon electrodes at currents of 6.5 to 10 amp. On the basis of the evaporation curve of the impurities and investigation of the dependence of the line intensity on the content of the carbon powder, and silver chloride in the sample, the optimum conditions for the analysis and purification of scandium oxide for standards were selected. The method makes it possible to determine simultaneously 28 elements with sensitivity of 3×10^{-5} to 5×10^{-3}%. The mean square error of the determination is 7 to 20%. The method can be used for the analysis of different scandium compounds after their conversion to high-density oxide. (tr-auth)

18728 NONFERROUS METALLURGY. II. ZIRCONIUM, HAFNIUM, VANADIUM, NIOBIUM, TANTALUM, CHROMIUM, MOLYBDENUM, AND TUNGSTEN. Bachman, Robert Z.; Banks, Charles V. (Iowa State Univ., Ames). Contract W-7405-eng-82. Anal. Chem., 39: 110R-133R(April 1967). (IS-1540).

A review of methods for the determination of Zr, Hf, V, Nb, Ta, Cr, Mo, and W is presented. The various methods are summarized in tabular form. Various separation methods are presented. (613 references) (B.L.M.)

18729 VOLUMETRIC DETERMINATION OF MOLYBDENUM AS LEAD MOLYBDATE BY USING DITHIZONE AS AN INTERNAL INDICATOR. Ueda, Shunzo; Yamamoto, Yoshikazu; Takenouchi, Hitoshi (Kanazawa Univ., Kodatsuno, Japan). Nippon Kagaku Zasshi, 88: 1299-1302(Dec. 1967). (In Japanese).

The pH value of the sample solution containing about 10 to 70 mg of molybdenum oxide (M) was adjusted to 4.8 to 5.5 with ammonium acetate solution and acetic acid. It was titrated with 0.01 to 0.05 mole/l solution of lead nitrate using 1 ml of 0.03% dithizone solution in chloroform as indicator. At the end point the color of dithizone changed from green to reddish violet. Best results were obtained when chloroform was used as solvent of dithizone. Potassium, sodium, magnesium, and nickel did not interfere with the determination. Interferences of copper, cobalt, zinc, aluminum, iron, calcium, strontium, and barium may be eliminated by passing the sample solution in a cation exchange column prior to the titration. (auth)

18730 ON THE THORIUM CONTENT OF PRIMARY STANDARD GRADE AMMONIUM HEXANITRATOCERATE: AN OPTICAL EMISSION SPECTROGRAPHIC STUDY. Fassel, Velmer A.; Jasinski, Raymond J.; DeKalb, Edward L.; Lucas, William V. (Iowa State Univ., Ames). Anal. Chem., 40: 321-4 (Feb. 1968). (IS-1636).

The results of a study on the emission spectrometric determination of Th in Ce compounds are presented, and a procedure for the quantitative determination of Th is described. With this procedure, the ThO_2 content of ammonium hexanitratocerate can be determined quantitatively down to 30 ppM and detected down to 16 ppM. The failure of prior investigators to detect the presence of appreciable amounts of Th impurity by emission spectrometric methods in primary standards or reference grade Ce compounds is attributed to line misidentification in the published wavelength tables of Ce. The Th content of a series of typical "Reagent," "Primary Standard," and "Standard of Reference," samples of ammonium hexanitratocerate are tabulated and the significance of these results in terms of the use of this compound as a primary standard is discussed. (auth)

18731 COUNTING OF TRITIATED COMPOUNDS ON PAPER CHROMATOGRAMS. De Bersaques, J. (Univ. of Ghent). Int. J. Appl. Radiat. Isotop., 19: 166-9(Feb. 1968).

Factors that must be considered in the selection of counting methods for labeled substances on paper chromatograms are

briefly reviewed. Only very low efficiency is attainable in the counting of ^{3}H by use of GM or proportional 4π continuous or step-by-step scanners, with the result that scintillation techniques were introduced. The geometry of the paper in the counting vial containing the scintillating solution may appreciably influence the counting efficiency, and a large part of the electron emission from insoluble substances was absorbed by the paper fibers before reaching the scintillator. Partial dissolution of the sample is the worst situation. The presence of small amounts of water in commercial solvents is sufficient to extract "insoluble" materials from highly active spots. It is best to endeavor to achieve complete extraction from the paper into the scintillator, resulting in higher efficiency and more reproducible results. The presence of paper, water, and a water soluble active compound in the same vial gives a more complicated situation than with a purely organic solution, since the distribution of the water and water soluble substances between the stationary paper phase and the liquid phase is in favor of the former. Some experiments are described that illustrate this. Some results are tabulated for the counting efficiency for adenosine-^{3}H on filter paper using various scintillators; also for toluene-^{3}H and water-^{3}H, including quenching due to the paper. (UK)

18732 MEASUREMENT OF TRITIUM IN HETEROGENEOUS AND HOMOGENEOUS COUNTING SYSTEMS. Dobbs, H. E. Int. J. Appl. Radiat. Isotop., 19: 155-7(Feb, 1968).

Variations in counting efficiency were observed when measuring tritiated compounds on paper chromatograms with a gas-flow proportional counter connected to a ratemeter and recorder. The peak area on the tracing from a spot containing tritium-labeled benzoic acid was approximately four times that of a spot containing a similar quantity of radioactivity in the form of tritiated stearic acid on the same chromatogram. After spotting solutions onto paper, different levels of activity were recorded on opposite sides of the same paper, and these differences were maintained after passage of the solvent along paper during chromatography. It was concluded that when measuring tritium in a heterogeneous counting system, it is necessary to calibrate the method for each compound to be assayed; and when dealing with small quantities it is preferable to treat tritium-labeled compounds in such a manner that they form homogeneous counting systems. Homogeneous liquid scintillation counting is discussed with respect to suitable solvents. Surface adsorption, emulsion counting, and combustion methods are also discussed. (D.H.M.)

18733 APPARATUS FOR MEASURING THE CONCENTRATION OF A SPECIFIC CONTAMINANT IN A SUBSTANCE. (to Atomic Energy of Canada Ltd.). British Patent 1,103,386. Feb. 14, 1968. Priority date Sept. 1, 1964, Canada.

An apparatus for measuring the concentration of a specific contaminant in a substance is described specifically for the detection of the presence of heavy water leakage into light water as in the coolant and control systems of reactors. A mixture of the substance and contaminant shows a first absorption length in one wavelength band of the electromagnetic radiation spectrum and a second wavelength band dependent upon concentration of the contaminant. The apparatus is made up of a sample cell, means for illuminating the cell, means for detecting illuminating radiation passing through samples in the cell, means for placing a first sample containing a known concentration of specific contaminant and a second sample containing an unknown concentration of specific contaminant alternately in the cell, a first and second filter for permitting radiation transmission substantially only in the first and second wavelength bands, means for interposing the filters between the illuminating means and detection means, and means for measuring the difference in transmission through the first and second samples and comparing the output when the first and second filters are in position. (B.L.M.)

18734 ANALYTICAL TOXICOLOGY OF INDUSTRIAL INORGANIC POISONS. Jacobs, Morris B. Chemical Analysis, A Series of Monographs on Analytical Chemistry and its Applications. Volume 22. New York, John Wiley and Sons, Inc., 1967. 968p. $25.00.

The sampling, measurement, and determination of various industrial poisons including gases, solids, and liquids are discussed. Detailed information is given on dusts, silica, arsenic, mercury, and other harmful metals, oxygen, ozone, carbon monoxide, carbon dioxide, cyanides, nitriles, and compounds of sulfur, phosphorous, nitrogen, and the halogens. A chapter on radiochemical determinations is included. An evaluation of the absorption of several poisonous metals and specific methods for their determination in blood and urine are also included. The appendix consists of eighteen tables with data on safe concentration limits of various poisons and atmospheric pollutants. Author and subject indexes are included. (J.G.B.)

18735 THE MOESSBAUER EFFECT AND ITS APPLICATION IN CHEMISTRY. A Symposium held in New York, N. Y., September 12, 1966. Gould, Robert F. (ed.). Advances in Chemistry Series 68. Washington, D. C., American Chemical Society, 1967. 185p. $6.50. (CONF-660959).

Topics covered include: the Moessbauer effect and its applications in chemistry; structural studies of compounds and alloys using the Moessbauer effect; study of magnetic properties of materials using the Moessbauer effect; studies of coordination chemistry and biochemicals using this effect; Moessbauer studies of tektites, pyroxenes, and olivines; Moessbauer spectroscopy of iron compounds; the Moessbauer chemical shift in tin chemistry; Moessbauer spectroscopy of the rare earths; Moessbauer spectroscopy of iodine; and Moessbauer spectroscopy of tellurium. (M.C.G.)

18736 IMPROVEMENTS IN RADIOMETRIC ANALYSIS. Starnes, Peter Edward (to Hilger and Watts Ltd.). British Patent 1,103,562. Feb. 14, 1968. Filed Apr. 8, 1964.

A radiometric method is described for the analysis of fine solids suspended in a liquid. The suspension is fed into a mixing tank and subjected to slow speed agitated with or without the application of reduced pressure. The suspension is then flowed into a density gage where it is interacted with a beam of electromagnetic radiation, the photons of which have energies principally in the energy range 600 to 3000 keV. The length of flow path through the gage is such as to provide optimum conditions for the measurement of the attenuation of the radiation, and the velocity of flow is such as to prevent sedimentation or segregation taking place. A comparison of the intensity of the radiation transmitted through the suspension in the density gage with the intensity of a measurement of the radiation transmitted through a reference standard under similar conditions gives a measure of the density of the suspension. The suspension is then flowed through one or more cells or conduits under conditions of controlled pressure, velocity, and flow pattern so that interaction occurs between the suspension and primary radiation incident upon it. With all conditions being accurately maintained, the radiation resulting from the interaction is compared with that produced from the same source with a reference standard. A combination of these radiation measurements and the measurements from the density gage yield information relating to the chemical composition of the solids present in the suspension. (B.L.M.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 18710, 18811, 18945, 19042, 19469, 19617, and 20558.

18737 (AERE-Bib-157) LIST OF UNCLASSIFIED DOCUMENTS, LECTURES ETC., BY THE STAFF OF THE CHEMISTRY DIVISION, A.E.R.E., HARWELL, 1967. Bibby, E. A. (comp.) (Atomic Energy Research Establishment, Harwell (England)). Feb, 1968. 16p. Dep. CFSTI. UK 3s. 0d.

Reports, memoranda, conference papers, books, lectures, and articles in journals are listed. (auth)

18738 (MLM-1417) MOUND LABORATORY PROGRESS REPORT FOR CHEMISTRY, APRIL-JUNE 1967. (Mound Lab., Miamisburg, Ohio). June 30, 1967. Contract AT(33-1)-Gen-53. 36p. Dep. CFSTI.

Progress is reported on research on: half-life determination by decaying pairs, residue adsorption, alpha-beta branching ratio of ^{227}Ac, radiochemistry of osmium, ^{234}U recovery, ^{229}Th recovery, ^{227}Ac production, techniques for measuring internal conversion coefficients, crush strength apparatus, x-ray diffraction of rubidium uranyl nitrate, and determination of organic materials in water. (M.C.G.)

18739 (ORNL-4221) X-RAY DIFFRACTION DATA ON THE SYSTEM WATER-AMMONIA AT 4°C. Narten, A. H. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 53p. Dep. CFSTI.

The scattering of x rays from the free surface of aqueous solutions containing 18.3 and 28.5 mole % NH_3 and of pure ammonia was measured and analyzed at 4°C. Both the raw data and the intensity and radial distribution functions derived from them are presented in tabulated form. The curves for the ammonia-water system are compared with previously obtained results for pure water at the same temperature. (auth)

18740 (RMD-5097-F) SYNTHESIS OF POLYAMMONIUM BOROHYDRIDE SALTS. Report Period: September 30, 1966-September 29, 1967. Falk, Robert A. (Thiokol Chemical Corp.,

Denville, N. J. Reaction Motors Div.). Oct. 27, 1967. Contract W-7405-eng-48. 22p. (UCRL-13320). Dep. CFSTI.

For California Univ., Livermore. Lawrence Radiation Lab.

Several poly(quaternary ammonium)borohydride salts having a high volume percentage of hydrogen and boron were prepared. These polymeric salts are of interest as neutron moderators and samples were submitted for evaluation by LRL. The salts were prepared from quaternized polyethylenimine of molecular weight 60,000 and 100,000. A number of unsuccessful experiments to prepare a bicyclic quaternary polymer are described. Finally, a dense bicyclic quaternary salt was prepared from pyrazino [2, 3-b] pyrazine, namely octamethylpyrazino [2, 3-b] pyrazinium dodecahydrododecaborate. (auth)

18741 (UCRL-50108(Vol.1)(Suppl.1)) COMPENDIUM OF SHOCK WAVE DATA. van Thiel, M.; Kusubov, A. S.; Mitchell, A. C. (eds.) (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 1967. Contract W-7405-eng-48. 524p. Dep. CFSTI.

New and corrected pages on thermodynamic data in condensed media obtained by shock wave techniques are given for inclusion in the original publication which was abstracted in NSA 21: 5848. Indexes are included. (F.S.)

18742 (UCRL-50108(Vol.2)(Suppl.1)) COMPENDIUM OF SHOCK WAVE DATA. van Thiel, M.; Kusubov, A. S.; Mitchell, A. C. (eds.) (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 1967. Contract W-7405-eng-48. 231p. Dep. CFSTI.

New and corrected pages are given for inclusion in the original publication UCRL-50108. Thermodynamic data obtained by shock wave techniques are presented in graph and tabular form for hydrocarbons, organic compounds, and mixtures (organics, alloys, explosives, etc.). Material indexes are included. (D.L.C.)

18743 (EURFNR-417) OXIDATION OF PLUTONIUM (IV) TO PLUTONIUM (VI) USING MANGANESE DIOXIDE. Vogg, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Translation of report KFK-621. 13p. (EUR-3690). Dep. CFSTI.

Work performed under United States-Euratom Fast Reactor Exchange Program.

Manganese dioxide prepared by acid reactions with potassium permanganate at 60 to 70°C with the addition of Cr-Ni steel swarf can oxidize plutonium(IV) to plutonium(VI) in a nitric acid medium. The best method for total oxidation is a manganese dioxide column; quantitative recovery of the plutonium from the column is guaranteed at a minimum nitric acid concentration of 2N and a minimum temperature of 30°C. (auth)

18744 (ORNL-tr-1854) CHELATE FORMATION OF TRIVALENT TRANSPLUTONIUM ELEMENTS WITH NITRILOTRIACETIC ACID AND ITS DERIVATIVES. Ali, Sameh Abdel Hadi (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)). Translated from report KFK-580. 71p. Dep. CFSTI. JCL $7.60 fs, $2.36 mf.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 6291. (J.G.B.)

18745 REACTION OF D_2^+ WITH CYCLOHEXANE. Futrell, Jean H.; Abramson, Fred P.; Tiernan, Thomas O. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Phys. Chem., 72: 1071-4(Mar. 1968).

A gas-phase experiment of impacting D_2^+ on cyclohexane at various ion energies was performed, and the ionic products of the reaction were examined. D_2^+ ions were formed by electron impact on D_2 in the ion source of the first-stage mass spectrometer, accelerated, both energy and mass selected, decelerated to terminal energy, and impacted on cyclohexane vapor in a differentially pumped collision chamber. The lowest energy investigated approached thermal velocities (ion energy 0 to 0.5 eV). Ions monochromatic in energy to this degree were then impacted on cyclohexane at various energies up to 20-eV nominal ion kinetic energy. The distribution of cyclohexane ions from the reaction of 0 to 0.5 eV D_2^+ ions is reported. At this energy no signal was detected at m/e 2(D^+) or at m/e 5 (D_2H^+). At 2 eV a D^+ signal was barely discernible above the noise level and appeared to increase slightly with increasing energy. Within experimental error the spectrum of hydrocarbon product ions at 5 eV was the same as that reported for low energy ions; therefore, it was concluded that translational energy of ions was not effectively converted into internal energy of the reacting system. (D.H.M.)

18746 CRYSTAL AND MOLECULAR STRUCTURE OF ACETATE-BRIDGED URANYL COMPOUNDS. Panattoni, C.; Bandoli, G.; Graziani, R.; Croatto, U. (CNR, Padua). Chem. Commun., No. 5, 278-9(1968).

Two new isomorphous and isostructural uranyl aceto-compounds with triphenyl derivatives of phosphorus and arsenic oxides, formulated as $[UO_2(AcO)_2Ph_3PO]_2$ and $[UO_2(AcO)_2Ph_3AsO]_2$, were prepared. Crystal structure data are given. The dimeric molecules was found to be centrosymmetric. The structure was solved by the heavy atom procedure, and refinement carried out by the block-diagonal least-squares method, using isotropic temperature factors. A perspective view of the dimer is shown, and the most significant bond lengths and angles are reported. Hepta-coordination is realized with the U-atom at the center of a pentagonal bipyramid formed by five O-atoms in the equatorial plane normal to the uranyl group. The phosphorus compound is defined as trans-di-μ-acetato-bis-(dioxotriphenyl phosphine oxide acetato) diuranium (VI). (UK)

18747 CHEMISTRY OF THE 102 ELEMENT. I. ADSORPTION OF THE 102 CHLORIDE FROM THE GASEOUS PHASE. Chuburkov, Yu. T.; Tsaletka, R.; Shalevskii, M. R.; Zvaro, I. Radiokhimiya, 9: 637- (1967). (In Russian).

Properties of element 102 (Nobelium) were studied. The volatility (adsorption from the gaseous state on solid surfaces) of the 102 chloride was similar to that of those of Tb, Cf, and Fm. The separation of high-purity element 104 from the ^{256}No, during identification of the ^{260}104 element, was achieved due to the strong contrast in the volatility of the elements. (R.V.J.)

18748 COMPARATIVE FORMATION OF AMALGAMS OF TRANSURANIUM ELEMENTS AND RARE EARTHS BY ELECTROLYSIS. David, F.; Bouissieres, G. (Laboratoire Joliot-Curie, Orsay, France). Inorg. Nucl. Chem. Lett., 4: 153-9 (Mar. 1968).

Preliminary studies indicated that the lanthanides and cis- and trans-uranium elements do not behave as two groups of homologous elements with regard to amalgamation. The amalgamation yields obtained by the action of Li amalgam on citric solutions of the lanthanides showed maxima for La, Eu, and Yb. For the actinides maxima were observed for Ac and Cf. The behavior of Cf was very different from that of Dy. The kinetics of formation of the amalgams by electrolysis at a mercury cathode in the presence of lithium citrate were investigated. Results are reported concerning electrolysis studies carried out with Pu, Am, Cm, Bk, and Cf. Some electrolysis experiments were also carried out on solutions of Np(V), in order to ascertain whether the initial valency of the element had any influence on the amalgamation period. The other elements were studied in the 3-valent state. Californium showed a marked tendency to form an amalgam, and einsteinium, fermium, and medelevium have been shown to be even more easily amalgamated than californium. Details of the experimental procedure are given, and the results obtained are discussed. The Np(V) characteristic curve was significantly different from the curves for the 3-valent elements. It was also found that Pa is virtually non-amalgamable in aqueous solution, an indication of the great difficulty in reducing this element beyond the 4-valent state. The curves for Ac, Pu, Am, Cm, Bk, and Cf showed a very comparable aspect to those for the lanthanides. This similar behavior of the two groups of elements indicates that the proposed interpretation for the kinetics of the rare earth amalgamations is also applicable to the transuranium elements in solution in the 3-valent state. The more unstable the intermediate divalent state, the longer is the amalgamation period. The results indicate the possibility of an easy separation of, for example, Ac from Th and Pa; Np from Pa; or Cf from Ho, Er, Tm, and Lu. (UK)

18749 MICROWAVE SPECTRA OF THE ETHYL ALCOHOL MOLECULE. Culot, Jean-Pierre (Centre de Physique Nucleaire, Louvain, Belg.). Ann. Soc. Sci. Brux. Ser. 1, 81: 272-91(Dec. 31, 1967). (In French).

The microwave spectra of the molecules CD_3-CD_2-OH and CD_3-CD_1-OH were measured in the range 9 to 50 GHz. The application of Watson's formula, to determine the correction of the torsion, permitted the assignment of several transitions due to the component of the dipole moment along the b axis. These transitions correspond to the trans configuration for which the hydroxyl group is found in the plane of symmetry of the molecule. A fictitious molecular model was constructed that permits the calculation, with better precision, of the rotation constants of the isotopic derivatives of ethyl alcohol. (tr-auth)

18750 STRUCTURE AND ION-EXCHANGE CHARACTERISTICS OF POLYANTIMONIC ACID. Baetsle, L. H.; Huys, D. (SCK-CEN, Mol, Belg.). J. Inorg. Nucl. Chem., 30: 639-49(Feb. 1968).

The chemical analysis of a hydrated antimony oxide showed that its composition may be represented by the empirical formula $Sb_2O_5 \cdot 4H_2O$. By x-ray analysis a cubical unit cell of 10.3 Å and a face-centered symmetry were determined, leading to the formula

$\{[H_5Sb_5O_9(OH)_8]_3[H_8Sb_5O_8(OH)_{18}]\}$. The ion exchange capacity amounts to 5.05 m-equiv/g and the compound is very selective for Ag^+, Pb^{2+}, Tl^+, and Sr^{2+}. The ion-exchange mechanism is very similar to that for zeolites, although the origin of the induced charges is ascribed to polymerization and condensation of antimony oxide. At very low loading polyantimonic acid has a pronounced selectivity for Sr^{2+} in an acid medium. (auth)

18751 KINETIC DEUTERIUM ISOTOPE EFFECT IN NITROGEN COUPLING IN AN APROTIC MEDIUM. Szman, O.; Messmer, A. (Hungarian Academy of Sciences, Budapest). Tetrahedron Lett., No. 13, 1625-9(Feb. 1968). (In German).

The reaction of p-methoxybenzenediazonium borofluoride with aromatic amines in nitrobenzene was shown to give the corresponding azo-compound hydroborofluorides with over 75% yield. The reaction mechanism was studied by kinetic measurements, using photometric estimation of unreacted diazonium salt, and found to be third-order; this is explained by a type of catalytic process, which should lead to a kinetic isotope effect. To test this, >90% deuterated amines were prepared by 20 min. boiling in D_1-acetic acid. A considerable isotope effect was found with the weakly basic α- and β-naphthylamines, a slight effect in dimethylaniline, and no effect in m-toluidine. It is concluded that a deuterium isotope effect in nitrogen coupling occurs not only in cases of steric hindrance, but whenever the medium is aprotic and the amine is a fairly weak base. (UK)

18752 CALCULATION OF FRACTIONATION FACTORS FOR CARBON AND OXYGEN ISOTOPIC EXCHANGE IN THE SYSTEM CALCITE–CARBON DIOXIDE–WATER. Bottinga, Y. (Univ. of California, San Diego). J. Phys. Chem., 72: 800-8(Mar. 1968).

Partition-function ratios for $H_2{}^{18}O/H_2{}^{16}O$, $C^{18}O_2/C^{16}O_2$, $CaC^{18}O_3/CaC^{16}O_3$, $^{13}CO_2/^{12}CO_2$, and $Ca^{13}CO_3/Ca^{12}CO_3$ were calculated. Water vapor and carbon dioxide were treated as ideal gases, but vibrational anharmonicity effects were taken into account. The calcite partition function ratios were calculated by adopting the Giulotto–Loinger model for the acoustical, optical, and librational lattice modes; the orbital–valence force-field method was used for the carbonate ion vibrational frequencies. For oxygen isotopic exchange between CO_2 and calcite, the calculated fractionations can be expressed as $1000 \ln \alpha_g = -3.2798 + (1.0611 \times 10^4/T) - (1.8034 \times 10^8/T^2)$, for the temperature interval 0 to 550°C; for carbon exchange, the corresponding equation is $1000 \ln \alpha_c = -2.4612 + (7.6663 \times 10^3/T) - (2.9880 \times 10^6/T^2)$. The calculated fractionation factors for isotopic exchange in the systems carbon dioxide–calcite and carbon dioxide–water agree with the observed ones. The agreement is less satisfactory for the oxygen isotopic fractionations between calcite and water above 100°C. (auth)

18753 ISOTOPIC EXCHANGE OF OXYGEN ON PLATINUM POWDER. Sandler, Y. L.; Durigon, D. D. (Westinghouse Research Labs., Pittsburgh). J. Phys. Chem., 72: 1051-7(Mar. 1968).

A kinetic study of the isotopic oxygen exchange on platinum powders between −195 and +300°C is presented. Three different weak modes of chemisorption were found that change with time and temperature. Adsorption and isotopic dilution experiments showed that no oxygen beyond the equivalent of one monolayer was in or on the powders which were well annealed and freed of carbon and hydrogen. The uptake of several monolayers of oxygen described in the literature appears to be caused by the presence of impurities or a high concentration of defects. Nitrogen did not exchange on platinum or interfere with the oxygen exchange up to 600°C. (auth)

18754 ON THE "HYDROLYTIC" URANIC ACID. Baran, Vaclav. (Nuclear Research Inst., Czechoslovak Academy of Sciences, Rez). Z. Anorg. Allg. Chem., 355: 88-93(Nov. 1967).

"Hydrolytic" uranic acid, the mother substance from which uranates can be really prepared as well as formally deduced, is prepared from uranyl solutions using alkalization by means of an anion exchange resin in OH-form. The product is identified as the so-called uranium trioxide dihydrate, α-$UO_3 \cdot 2\ H_2O$. Its behavior as an actual acid is verified by preparing uranates in neutralization reaction. Its formula is proposed. (auth)

18755 STUDIES OF THE IONIC SPECIES OF PROTACTINIUM IN AQUEOUS MEDIA. V. HYDROLYSIS AND POLYMERIZATION OF TETRAVALENT PROTACTINIUM. Guillaumont, Robert (Institut de Physique Nucleaire, Val-de-Marne, France). Bull. Soc. Chim. Fr., No. 1, 162-8(Jan. 1968). (In French).

In 3N perchloric acid, tetravalent protactinium occurs in the state of Pa^{4+} ions, in the scale of indicators. When the acidity decreases, hydrolysis is responsible for the appearance of $PaOH^{3+}$, $Pa(OH)_2^{2+}$ and $Pa(OH)_3^+$. The Pa^{4+} ions and the hydrolyzed forms derived from them are polymerized when the concentration of the element is of the order of 10^{-6} to 10^{-5} M. These results are obtained by studying the extraction of Pa^{4+} in benzene by the formation of a chelate with thenoyltrifluoroacetone. Hydrolysis constants are calculated for Pa^{4+}. (auth)

18756 STUDIES OF THE IONIC SPECIES OF PROTACTINIUM IN AQUEOUS MEDIA. VI. DETERMINATION OF THE SECOND HYDROLYSIS CONSTANT OF PENTAVALENT PROTACTINIUM. Guillaumont, Robert (Institut de Physique Nucleaire, Val-de-Marne, France). Bull. Soc. Chim. Fr., No. 1, 168-70(Jan. 1968). (In French).

The second hydrolysis constant for the cation $PaOOH^{2+}$ was calculated by studying the extraction of Pa(V) in benzene by the formation of chelate with dibenzoylmethane. For ionic strength 3: $[Pa(OH)_5][H^+]^2/[PaOOH^{2+}] = 2.84 \cdot 10^{-6} \cdot mole^2 \cdot l^{-2}$. (auth)

18757 SCATTERING OF THERMAL NEUTRONS BY LIQUID SOLUTIONS OF ORTHO- AND PARADEUTERIUM. Talhouk, S. J.; Harris, P. M.; White, David; Erickson, R. A. (Ohio State Univ., Columbus). J. Chem. Phys., 48: 1273-82(Feb. 1, 1968). (NYO-3783-2).

The structures of two samples of liquid deuterium, one enriched in paradeuterium (85% para-D_2) and the other enriched orthodeuterium (the 20°K equilibrium concentration 96.9% ortho-D_2), have been investigated by diffraction of 1-Å neutrons. The scattering data have been interpreted both as an assemblage of atom scatterers and, somewhat more exactly, as molecular scatterers. Fourier inversion of the intermolecular scattering yields a radial distribution interpretable for both samples as exhibiting approximately 10.3 nearest-neighbor molecules (cf 12 for close packing of spheres). In the case of the converted sample (96.9% J = 0, nonrotating D_2) the nearest-neighbor molecules are at a mean distance of 3.85 Å from the reference molecule; in the enriched sample (85% J = 1) the nearest-neighbor distance is 3.72 Å corresponding to a smaller molar volume attributable to the angular anisotropy of the intermolecular interactions when the rotations are hindered. Small-angle scattering also indicates a higher compressibility for the 96.9% para-D_2 (J = 0) sample. (auth)

18758 RELATIVE SIGNS OF NMR COUPLING CONSTANTS AND ISOTOPE SHIFTS IN AMMONIUM IONS. Johannesen, Rolf B. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 48: 1414-15(Feb. 1, 1968).

The measurement of the relative signs of $J_{^{14}NH}J_{^{15}NH}$ in isotopically substituted ammonium ions by testing the connections between lines of different multiplets split by the coupling constant in question are reported. Isotopic shifts were found in the proton spectrum upon substitution of D, such that NH_3D^+ was found 0.017 ppM downfield of NH_4^+. The proton spectrum showed no shift between $^{14}NH_4^+$, within the limits of ±0.10 Hz. The nitrogen spectra showed an isotope shift between NH_4^+ and NH_3D^+ of 0.2 to 0.4 ppM, such that NH_4^+ was found downfield of NH_3D^+. (P.C.H.)

18759 HYDROXYL RADICAL KINETICS BY KINETIC SPECTROSCOPY. IV. SOME DEUTERIUM ISOTOPE EFFECTS. Greiner, N. R. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 48: 1413(Feb. 1, 1968). (LA-DC-9007).

The effects of deuterium on reactions of D_2 with OH and OD with CH_4 and C_2H_6 were studied at 300°K. A value of 4.4 kcal $mole^{-1}$ for $E_1 - E_7$ and 17 for A_1/A_7, where E and A refer to parameters in the Arrhenius equation $k = A \exp(-E/RT)$, were found. It appeared from the results that $E_1 - E_4 \cong 0.4$ kcal $mole^{-1}$ and $A_1/A_4 \cong 0.5$. (P.C.H.)

18760 EXCHANGE AND FRACTIONATION OF NITROGEN ISOTOPES BETWEEN NO_2^- AND NO_3^-. Brown, L. L.; Drury, J. S. (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 48: 1399-1400(Feb. 1, 1968). (ORNL-P-3429).

The fractionation factor for the reaction $^{15}NO_2^-(aq) + {}^{14}NO_3^-(aq) = {}^{14}NO_2^-(aq) + {}^{15}NO_3^-(aq)$ was measured under conditions sufficiently similar to those existing in the $NO-HNO_3$ system for the results to be meaningful. Conditions for the reaction were established in an aqueous solution containing sufficient NO_2^- and NO_3^- for sampling, and the participating species were separated quantitatively without disturbing the isotopic equilibrium. By combining the present data with the results obtained by others for the exchange of N between NO and HNO_3 (α = 1.086 at 0°C), an estimate, α = 1.027, was obtained for the fractionation factor for the exchange of nitrogen between NO and NO_2^-. (P.C.H.)

18761 CALCULATION OF THE INFRARED INTENSITY PRODUCED IN THE TORSIONAL VIBRATION OF ETHANE BY CORIOLIS INTERACTION. Eggers, David F. Jr. (Univ. of Washington, Seattle). J. Chem. Phys., 48: 1393-4(Feb. 1, 1968).

Coriolis constants were computed for ethane. A similar calculation was carried out for C_2D_6, in which only one vibration, the CD stretching fundamental, was included. For CH_3CD_3 both CH

and CD stretching were found to have important contributions. Experimental quantities for comparison were obtained by area measurements on the original spectra; only that part of the Q branch extending above the neighboring background was included. The results strongly suggest that the torsional fundamental obtains its intensity by Coriolis interaction with the parallel CH and CD stretching fundamentals. (P.C.H.)

18762 APPLICATION OF FINITE ORTHOGONAL POLYNOMIALS TO THE THERMAL FUNCTIONS OF HARMONIC OSCILLATORS. I. REDUCED PARTITION FUNCTION OF ISOTOPIC MOLECULES. Bigeleisen, Jacob; Ishida, Takanobu (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 48: 1311-30(Feb. 1, 1968). (BNL-11751).

The utility as well as limitations of the Taylor series expansion of the quantum-mechanical partition function of a harmonic oscillator is discussed. Finite orthogonal polynomials are suggested as a basis for the approximation of the thermodynamic functions of an assembly of harmonic oscillators. Shifted Chebyshev polynomials of the first kind are used to obtain finite expansions of arbitrary order of the reduced partition functions of isotopic molecules. The resulting series is similar, except for modulating coefficients, term by term to the Bernoulli series obtained from the Taylor expansion. The modulating coefficients of each term in the Chebyshev expansion approach unity as the order of the expansion increases. Thus, the Chebyshev series developed here approaches the Bernoulli series asymptotically. The Chebyshev expansion converges much faster than the Bernoulli expansion. The radius of convergence can be made arbitrarily large in contrast to the limit of 2π which exists for the Bernoulli expansion. These features of the Chebyshev expansion provide a basis for the extension of the principles of isotope effects, derived from quantum corrections of order $(\hbar/kT)^{2n}$, to the complete spectrum of energy states. The mathematical behavior of the modulating Chebyshev coefficients is examined. Detailed application of the Chebyshev expansion to typical polyatomic molecules is given through numerical calculations. (auth)

18763 EXCHANGE AND FRACTIONATION OF NITROGEN ISOTOPES BETWEEN NO AND NO_2^-. Brown, L. L.; Drury, J. S. (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 48: 1400(Feb. 1, 1968). (ORNL-P-3428).

The separation factor for the reaction $^{15}NO(g) + {}^{14}NO_2^-(aq) = {}^{14}NO(g) + {}^{15}NO_2^-(aq)$ was measured experimentally. Eight determinations yielded the value, $\alpha = 1.024 \pm 0.002$ (95% confidence level). Since the value still does not agree with spectroscopic data, it is believed that spectroscopic data do not consider anharmonic corrections and condensed phase effects. (P.C.H.)

18764 DEUTERIUM ISOTOPE EFFECTS ON THE LUMINESCENCE OF TERBIUM AND EUROPIUM CHELATES. Mikula, James J. (Frankford Arsenal, Philadelphia); Salomon, Robert E. J. Chem. Phys., 48: 1077-85(Feb. 1, 1968).

The intensity of luminescence of piperidiniumtetrakis(1-3-diphenyl-1,3-propanediono)Tb(III) in EPA is enhanced when the phenyl groups are deuterated. This luminescence has been measured as a function of temperature and the enhancement appears to be a constant over the temperature range studied. Similar studies when carried out with piperidiniumtetrakis(1,3-diphenyl-1,3-propanediono)Eu(III) with deuterated phenyl groups did not lead to any appreciable enhancement over that of the undeuterated complex. Similar results were obtained with deuterated and undeuterated tris dibenzoylmethides of Eu (III) and Tb (III). Increased ion emission was observed with deuterated Tb complex but not with the deuterated Eu complex. An explanation for the temperature dependence as well as the difference observed between the terbium and europium complexes is offered. (auth)

18765 PHYSICAL PROPERTIES OF FLUID CH_4 AND CD_4: THEORY. Grigor, Anthony F.; Steele, William A. (Pennsylvania State Univ., University Park). J. Chem. Phys., 48: 1038-46(Feb. 1, 1968).

Experimental data for the differences in the physical properties of CH_4 and CD_4 are subjected to a theoretical analysis. The theory is presented in a form that represents the total effects as sums of terms which are due to differences in the intermolecular potential functions plus other terms due to quantum effects on the translational, rotational, and (internal) vibrational degrees of freedom of the molecules. It was found that the differences in liquid molar volumes, isothermal compressibilities, and critical constants are almost entirely accounted for if it is assumed that the CD_4 molecule is 0.4% smaller than CH_4; that the depth of the intermolecular potential well is 0.9% smaller for CD_4 than for CH_4 and that other contributions to the net changes in these properties are small. The vapor-pressure differences are due only in part to the differences in potential function; in addition, the various quantum contributions to this property are estimated, and it was concluded that the translational and vibrational effects are important for the CH_4-CD_4 pair but that the rotational quantum effect can be neglected. It was found that the experimental vapor pressures and heat of vaporization differences can be accounted for if the vibrational zero-point energy change upon vaporization is chosen to fit the data at one point. (auth)

18766 PHYSICAL PROPERTIES OF FLUID CH_4 AND CD_4: EXPERIMENTAL. Grigor, Anthony F.; Steele, William A. (Pennsylvania State Univ., University Park). J. Chem. Phys., 48: 1032-7(Feb. 1, 1968).

Measurements of some physical properties of liquid and gaseous CH_4 and CD_4 are reported. The data were obtained at temperatures ranging from the freezing point up to 10° above the critical temperature and at pressures up to 70 atm. The measured quantities include vapor pressures, liquid molar volumes, liquid isothermal compressibilities, critical constants, and gas-phase molar volumes and compressibilities in the critical region. These results are compared with those of others and with some theoretical predictions of fluid behavior in the critical region. (auth)

18767 DIRECT OBSERVATION OF THE INFRARED TORSIONAL SPECTRUM OF C_2H_6, CH_3CD_3, AND C_2D_6. Weiss, Shmuel; Leroi, George E. (Princeton Univ., N. J.). J. Chem. Phys., 48: 962-7(Feb. 1, 1968).

The torsional spectra of gaseous C_2H_6, CH_3CD_3, and C_2D_6 have been observed directly in the infrared under high-pressure–path-length conditions (30 to 70 atm · m). The fundamental was observed for all three species, at 289, 253, and 208 cm^{-1}, respectively. Hot bands were observed for C_2H_6 (255 cm^{-1} [A], 258 cm^{-1} [E]) and CH_3CD_3 (228 cm^{-1}) as was the first overtone for CH_3CD_3 (482 cm^{-1}). All the experimental frequencies can be very well accounted for by use of a single internal rotation potential function with a barrier height $V_3 = 2928$ cal/mole. This implies that V_6 (and higher terms) are negligibly small. Two alternative explanations for the occurrence of these spectra in the infrared, one in terms of Coriolis interaction with an infrared-active vibration and one in terms of a $\nu_4 + \nu_x - \nu_x$ vibration, are discussed. A more reliable determination of ν_{12}, the "uncertain frequency" of C_2H_6, has been obtained from the $\nu_{12} - \nu_3$ difference band, giving $\nu_{12} = 1206$ cm^{-1}. (auth)

18768 PRELIMINARY INVESTIGATION OF AN 8-QUINOLINOL COMPLEX OF URANIUM(VI). Fleming, J. E.; Lynton, H. (Univ. of Victoria, B. C.). Can. J. Chem., 45: 1637-41 (July 15, 1967).

The results suggest that the chelate $UO_2(C_9H_6NO)_2 \cdot C_9H_6NOH$ can be crystallized from chloroform as orange-red crystals which are monoclinic, space group $P2_1$ with a = 14.98 Å (σ = 0.03 Å), b = 20.38 Å (σ = 0.05 Å), c = 14.75 Å (σ = 0.03 Å, and $\beta = 115.32°$ (σ = 0.20°). It is believed that six molecules are in the unit cell: three sets of molecules in the general positions (2a). The uranium positions have been established and show the higher symmetry $P2_1/m$ with four atoms in general positions and two atoms in the pseudo mirror planes. The molecular arrangement of 8-quinolinol molecules around the more general uranium atoms has been obtained from three-dimensional Fourier syntheses. This arrangement of 8-quinolinol molecules is essentially the same as found by others in the adduct $UO_2(C_9H_6NO)_2 \cdot C_9H_6NOH \cdot CHCl_3$. The molecular arrangement around the two remaining uranium atoms has not been established because of the false detail introduced by the pseudo-symmetry. This is enhanced by pronounced termination of series errors in the b-axis direction. (auth)

18769 PARAMAGNETIC RESONANCE IN FLUORIDE COMPLEXES OF URANIUM(V) OF THE TYPE UF_6M. Rigny, Paul; Plurien, Pierre (Centre d'Etudes Nucleaires, Saclay, Sif-sur-Yvette, France). J. Phys. Chem. Solids, 28: 2589-95(Dec. 1967). (In French).

The paramagnetic resonance absorption of polycrystalline fluoride complexes of pentavalent uranium of UF_6M type was studied at 3 cm wavelength and the boiling point of liquid nitrogen. The three compounds UF_6Li, UF_6Na, and UF_6Cs gave an asymmetric line in a field of about 9 kOe, the line shape being in agreement with an axial symmetry of the g tensor. In order to explain the unusual position of the resonance, the wave functions of a single 5f electron in an axial crystal field were calculated. The energy levels deduced from the g values agree with the position of the optical absorption peaks, and the crystal field parameters can be estimated. Analysis of the results indicates also the existence in these complexes of UF_7^- ions, which are about 5.15 Å apart and have the shape of axially distorted octahedra. Other complexes of type UF_6M(M = K, NH_4, Rb, Ag, Tl) gave no paramagnetic resonance signal under the same conditions, which can be due to large distortions of the UF_6 octahedra. (auth) (UK)

18770 KINETICS AND ISOTOPE EFFECTS IN SOLVOLYSES OF ETHYL TRIFLUOROMETHANESULFONATE. Streitwieser, A. Jr.; Wilkins, C. L; Kiehlmann, E. (Univ. of California, Berkeley). J. Amer. Chem. Soc., 90: 1598-1601(Mar. 13, 1968).

Acetolysis of ethyl trifluoromethanesulfonate ("triflate") was 30,000 times faster than that of ethyl tosylate at 25°C. Solvent effects and α- and β-deuterium isotope effects showed that acetolysis and formolysis of ethyl triflate has little carbonium ion character and much nucleophilic solvent displacement or N character. (auth)

18771 HYDROGEN–DEUTERIUM EXCHANGE IN A COBALT–NITROGEN COMPLEX. Parshall, G. W. (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Amer. Chem. Soc., 90: 1669-70(Mar. 13, 1968).

The exchange of D_2 with the hydridonitrogen complex, $HCo(N_2)(PPh_3)_3$ was studied. When benzene solutions of $HCo(N_2)(PPh_3)_3$ were allowed to equilibrate with deuterium gas at 25°C, the amount of hydrogen introduced into the gas far exceeded the amount available by exchange with the lone Co-H. The extent of exchange corresponded roughly to 19 hydrogen per mole of cobalt complex. Results from experiments suggest that not only the Co-H but also six aryl H's per phosphine ligand exchanged with the D_2 atmosphere, and that most, if not all, of the deuterium introduced into the triphenylphosphine ligands was in the position ortho to the phosphorus atoms. (D.H.M.)

18772 INSOLUBILITY OF AMERICIUM IN LIQUID AMMONIA. Gunn, S. R.; Morrow, R. J. (Univ. of California, Livermore). Inorg. Nucl. Chem. Lett., 4: 137-8(Mar. 1968).

Europium and ytterbium dissolve readily in liquid NH_3 to form typical dark blue solutions. Americium occupies a position in the actinide series corresponding to europium in the lanthanide series, but shows some tendency towards divalent character. In the studies described no solubility of americium in liquid ammonia was observed. (UK)

18773 EXAMINATIONS AND EQUIPMENT FOR ACCUMULATION, SEPARATION, AND STORAGE OF TRITIUM. Hosseini, S. M.; Puetz, W.; Erichsen, L. v. Atompraxis, 13: 457-61(Oct. 1967). (In German).

Among the methods used for labeling with tritium, Wilzbach's gas-exposure method is the most important today. For each run, it requires the use of tritium with a high specific activity of a magnitude of several curies. The preferred procedure for accumulating tritium is to bind the gas to metallic uranium in the form of UT_3. In order to avoid the metallic uranium's losing its binding capacity for hydrogen in the course of time as a result of impurities, or its explosive reaction as a metal or tritide through accidental admission of oxygen, a simple, completely closed apparatus for reversible conversion of UT_3 is described. It operates by forming or splitting UT_3 through suitable temperature adjustment, which renders a palladium tube permeable or impermeable for hydrogen. (auth)

18774 A β SECONDARY ISOTOPE EFFECT IN THE PHOTOCHLORINATION OF 2-METHYLPROPANE-2-t. Hodnett, Ernest M.; Juneja, Prem S. (Oklahoma State Univ., Stillwater). J. Org. Chem., 33: 1233-5(Mar. 1968).

In a study of the photochlorination of 2-methylpropane it was found that the primary hydrogen atoms were removed less rapidly from 2-methylpropane-2-t, indicating a β-secondary tritium isotope effect. The value for the β-secondary tritium isotope effect for the reaction was found to be 1.045 ± 0.004. (D.H.M.)

18775 THERMAL DECOMPOSITION OF TRI-SEC-BUTYL PHOSPHATE. Higgins, Cecil E.; Baldwin, Willis H. (Oak Ridge National Lab., Tenn.). J. Org. Chem., 33: 1065-6(Mar. 1968).

Since organic compounds containing sec-butyl groups are of practical importance in the solvent extraction technology of uranium, the thermal decomposition rates of, and isomeric olefin yields from, tri-sec-butyl phosphate are compound with those of tri-n-butyl phosphate. (auth)

18776 VAPORIZED AMOUNTS, VAPORIZATION BEHAVIOR AND SPECTRAL LINE INTENSITY OF GADOLINIUM IN GRAPHITE POWDER BY ARC DISCHARGE. Osawa, Hisao (Fuji Electric Co., Ltd., Nagasaka). Bunseki Kagaku, 17: 176-82(Feb. 1968). (In Japanese).

The relations between the vaporized amounts, vaporization behavior and spectral line intensity of gadolinium in graphite powder, and dc arc discharge conditions have been examined with graphite electrodes. Standard samples were prepared with highly purified graphite powder, 1000 ppM of gadolinium as gadolinium oxide and various concentration of lithium fluoride as a spectrographic buffer substance. A dc arc technique was used for exciting the element, and the neutron activation analysis technique was used for measuring the concentration of gadolinium in graphite powder after arc discharge. It was clarified that the vaporized amounts and vaporization behavior depended mostly on the electrode temperature. As an arc current increased, the vaporized amounts increased and the temperature of anode was raised. Under the experimental conditions including dc 9.9 A at 12.5 V, exposure time 60 sec, electrode gap 3 mm, and 2.0% of lithium fluoride in argon atmosphere, the vaporized amounts from mg sample were 3×10^{-7} g at anode crater and 2×10^{-7} g at cathode crater. The emission line intensity of gadolinium depended on the vaporized amounts of gadolinium in argon atmosphere. Under the experimental conditions including dc 9.8 ~ 10 A at 12.0 ~ 12.5 V, exposure time 60 sec, electrode gap 3 mm, and concentration of lithium fluoride from 0.5 to 10% the observed temperature range of the arc column was 2800 to 3600°K, and its correlation with the concentration of lithium fluoride was not linear. The arc column temperature was calculated by the equation; $\log (I_Y/I_{Ag}) = -5040E/T + C$. (auth)

18777 NATURAL AND ARTIFICIAL ROTATION IN CUBIC CRYSTALS OF URANYL COMPOUNDS. Burkov, V. I.; Kizel, V. A.; Krasilov, Yu. I.; Safronov, G. M. Zh. Prikl. Spektrosk., 7: 781-4(Nov. 1967). (In Russian).

The absorption spectra, rotational dispersion, and Faraday effect in crystals of sodium uranyl acetate and ammonium uranyl acetate and ammonium uranyl propionate were investigated. In the absorption spectra, there were three series of bands that were identified by fluorescence, magnetic, and differential methods. A noticeable contribution to the rotational dispersion was given by the first series and the heavy bands in the far ultraviolet. The rotational dispersion of ammonium uranyl propionate was shown by the second. It was assumed that the band responsible for the optical activity belong to the uranyl ions. The specific rotation, circular dichroism, and the circular absorption of the luminescence in the acetate was significantly lower; this is explained by the increase of the distance between ions. Only the magnetic series gives contributions to the Faraday effect. (tr-auth)

18778 PRELIMINARY ELECTROCHEMICAL STUDY OF PLUTONIUM IN CARBONATE SOLUTIONS ON HANGING MERCURY DROP ELECTRODE. Jeftic, Lj.; Caja, J.; Branica, M. (Inst. Ruder Boskovic, Zagreb). Croat. Chem. Acta, 39: 225-8(1967).

Electrode reactions of 1mM Pu (IV) in 1M Na_2CO_3 (I) and 0.5M Na_2CO_3 + 0.5 M $NaHCO_3$ (II) on the hanging mercury drop electrode are described. Cathodic, E_c and anodic, E_a peak potentials and transfer coefficient α for the one-electron reactions are given (potentials on the S. C. E. scale): (I) $E_c = -1.17$ V, $E_a = -0.10$ V, $\alpha = 0.68$; (II) $E_c = -1.12$ V $E_a = -0.12$ V, $\alpha = 0.67$. Formation of strong Pu-carbonato complexes is indicated. (auth)

18779 PRECIPITATION AND HYDROLYSIS OF THORIUM IN AQUEOUS SOLUTION. IV. STUDIES OF THE SYSTEMS: THORIUM NITRATE–SODIUM FUMARATE AND THORIUM NITRATE–POTASSIUM MALEATE. Bilinski, H.; Despotovic, Z. (Inst. Ruder Boskovic, Zagreb). Croat. Chem. Acta, 39: 165-74(1967).

Precipitation of thorium from aqueous solutions of thorium nitrate and sodium fumarate or potassium maleate was investigated for a broad range of concentrations of precipitation components and pH. From the results of chemical analyses and from the DTA and IR spectra the most probable formulas of the formed precipitates are: $Th(H\text{-fumarate})_2(OH)_2 \times 5\,H_2O$ and $[\overset{OH}{\overset{|}{Th}}(Mal\,\overset{OH}{\overset{|}{Th}}(OH)_4)] \times 6\,H_2O$. In the soluble mixed hydroxo maleato thorium complex, which is in equilibrium with thorium hydroxide, probably three hydroxide ions are bound to one thorium. It was found that with fumarate ion thorium does not form a soluble complex. (auth)

18780 USE OF CRYOSCOPY IN THE EUTECTIC ICE: ELECTROLYTE FOR THE INVESTIGATION OF THE POLYMERIZATION AND COMPLEX FORMATION OF IONS OF ZIRCONIUM AND URANIUM(VI) IN AQUEOUS SOLUTION. Komarov, E. V.; Krylov, V. N.; Pushlenkov, M. F. Zh. Neorg. Khim., 13: 467-71(Feb. 1968). (In Russian).

The utility of the method of "salt" cryoscopy for the study of the polymerization of metal ions in aqueous solution is shown. Cryoscopic investigation in the system ice–KNO_3 of solutions of $ZrO(NO_3)_2$ (0.10 to 0.25 mol/kg H_2O) in HNO_3 (m_{HNO_3} = 0, 0.4, 0.7, and 1.0 mol/kg H_2O) is reported. It is established that in the aqueous medium the mean degree of polymerization of Zr ions is $\bar{r} = 20$. With increasing acidity of the solution $\bar{r}$ decreases and equals at m_{HNO_3} = 0.4, 0.7, and 1.0 mol/kg H_2O 9.1, 7.7, and 7.7, respectively. In solutions of $UO_2(NO_3)_2$ (m = 0.05 to 0.2 mol/kg H_2O) at pH 3.30 to 3.70, the mean degree of polymerization of UO_2^{++} – $\bar{r} = 2.6$, but at pH 3.74 to 4.05 $\bar{r} = 5.0$. (tr-auth)

18781 DIURANATE OF AMMONIA AND THE HYDRATES OF URANIUM TRIOXIDE. Zubova, N. V.; Makarov, V. M.; Nikol'skii, V. D.; Petrov, P. N.; Teterin, E. G.; Chebotarev, N. T. Zh. Neorg. Khim., 13: 329-33(Feb. 1968). (In Russian).

The difference in thermal properties of the monohydrate of uranium trioxide and the diuranate of ammonia, exposed to hydrothermal treatment at 270°C, was shown. The molecular structures of the monohydrate and the diuranate were examined and confirmed that the first compound can be considered as uranyl hydroxide and the second as uranyl aquahydroxyammoniate. The role of the hydrogen bonds in the formation of these compounds was examined. (tr-auth)

18782 COMPOSITION OF SULFATE COMPLEXES OF URANIUM, FORMED DURING POLAROGRAPHIC REDUCTION OF URANYL IONS IN SULFURIC ACID MEDIUM. Stabrovskii, A. I. Zh. Neorg. Khim., 13: 406-11(Feb. 1968). (In Russian).

The effect of the complex formation of uranyl ions and uranium (IV) with sulfate ions on the electrode process was investigated. With an increase of the concentration of sulfate ions in the solution, the half-wave potentials of the first, second, and third reductions of U(VI) became more negative. The compositions of the sulfate ion complexes of U(V), $[UO_2(SO_4)]^-$, and U(III), $[U(SO_4)]^+$, in solution were determined by polarographic methods. (tr-auth)

18783 ON THE KINETICS OF BENZENE HYDROGENATION OVER NICKEL CATALYSTS IN A GRADIENTLESS SYSTEM. II. KINETICAL ISOTOPIC EFFECTS OF THE REACTION. Zlotina, N. E.; Kiperman, S. L. (Inst. of Organic Chemistry, Kazan). Kinet. Kataliz, 8: 1335-41(Nov.-Dec. 1967). (In Russian).

The magnitude of kinetic isotopic effects on benzene hydrogenation on nickel catalysts in a circulating system during protium replacement by deuterium in the initial substances was investigated. The magnitude was less than unity. The magnitude for an inverse reaction was determined using the direct reaction products. Thermodynamic isotopic effects using spectroscopic data and the value of the stoichiometric number of the limiting reaction equal to unity were calculated by correlation of kinetic isotope effect magnitudes for direct and inverse reactions. (tr-auth)

18784 SOLVOLYSIS MECHANISMS. β-DEUTERIUM ISOTOPE EFFECTS FOR t-BUTYL CHLORIDE SOLVOLYSIS AT CONSTANT IONIZING POWER AND EFFECT OF STRUCTURE OF REACTANT ON SN1 TRANSITION-STATE GEOMETRY. Frisone, Gino J.; Thornton, Edward R. (Univ. of Pennsylvania, Philadelphia). J. Amer. Chem. Soc., 90: 1211-15(Feb. 28, 1968).

The isotope effects (k_H/k_D) for the solvolysis at 25°C of t-butyl chloride and t-butyl-d_9 chloride in six solvent mixtures with the same "ionizing power," i.e., the same rate constant for undeuterated t-butyl chloride, are as follows: pyridine–water (51:49), 2.46 ± 0.03; 2-propanol–water (48:52), 2.42 ± 0.07; acetic acid–water (63:37), 2.41 ± 0.07; acetone–water (49:51), 2.40 ± 0.08; ethanol–water (54:46), 2.35 ± 0.03; acetic acid–formic acid (29:71), 2.30 ± 0.05. The numbers in parentheses are per cent by volume before mixing. The near-constancy of these isotope effects, despite considerable differences in electrophilic or nucleophilic properties of the various solvents, suggests that the structures of the solvolysis transition states (e.g., the extent of bond breaking) depend almost entirely on the amount of solvent assistance and not on the detailed nature of the assistance. This idea is reasonable if, as recent evidence strongly indicates, the transition state is ion pair like. A theoretical explanation of the transition-state geometry of SN1 and SN1–SN2 borderline reactions, which accounts for the puzzling features of these reactions, is suggested. (auth)

18785 MASS SPECTRAL MECHANISMS. N-ALKYL-3-CYANO-1,4-DIHYDROPYRIDINE FRAGMENTATION. KINETIC ISOTOPE EFFECTS FOR EXPULSION OF DEUTERIUM FROM THE 4 POSITION AND TRANSITION FROM QUANTAL TO PURELY CLASSICAL ISOTOPE EFFECT. Wang, Benjamin J.-S.; Thornton, Edward R. (Univ. of Pennsylvania, Philadelphia). J. Amer. Chem. Soc., 90: 1216-24(Feb. 28, 1968). (UCRL-17463).

The mass spectra of N-alkyl-3-cyano-1,4-dihydropyridines-4-d show elimination of a protium or deuterium atom from the 4 position of the molecular ion as the primary decomposition process. The ratio of rate constants for loss of these hydrogen and deuterium atoms was found to be inversely related to the ionizing voltage (k_H/k_D = 1.25 to 7.8 at voltages near the appearance potential). Most of the fragments were formed from the pyridinium ions resulting from loss of a hydrogen atom from the 4 position of the dihydropyridine. Rearrangement led to nicotinonitrilium ion (m/e 105). In order for N-methyl-3-cyanopyridinium ion to form m/e 105, it must expel methylene (CH_2) as a neutral fragment; this process is relatively unfavorable (2.8% of base peak). In the N-ethyl analog, expulsion of a thermodynamically stable ethylene molecule gave a m/e 105 peak that was the second most intense in the spectrum (95% of base peak). Deuterium labeling in the N-alkyl compounds methyl, ethyl, and n-butyl established that the hydrogen atom transferred to the ring to form the m/e 105 ion was preferentially from the β–carbon atom of the alkyl group, probably via a four-center transition state. The opening of the ring was found to occur by cleavage of the 1,2 and 5,6 bonds. Mass spectra of the N-n-propyl and N-n-pentyl analogs and of 1,4,4-trimethyl-1,4-dihydropyridine are also discussed. (auth)

18786 BEHAVIOUR OF CARRIER-FREE ^{32}P, FORMED IN ELEMENTARY SULPHUR BY THE NUCLEAR REACTION $^{32}S(n,p)^{32}P$, IN SOME ISOTOPIC EXCHANGE REACTIONS. Bebesel, Pavel I.; Turcanu, Corneliu N. (Inst. of Atomic Physics, Bucharest). J. Inorg. Nucl. Chem., 30: 369-74(Feb. 1968).

The isotopic exchange reactions of carrier-free ^{32}P, formed in elementary sulfur, with such compounds as PCl_3, $POCl_3$, and $PSCl_3$ were studied. Exchange was observed in the case of $POCl_3$ and $PSCl_3$. It was catalyzed by $AlCl_3$. Only the radiophosphorus atoms present in deaerated sulfur targets show this exchange. Further evidence is presented that two chemical states of carrier-free ^{32}P may be present in irradiated sulfur targets, depending on the presence or absence of oxygen included in the crystalline lattice of irradiated sulfur. (auth) (UK)

18787 ON THE PREPARATION AND SOME PHYSICAL PROPERTIES OF GADOLINIUM SESQUISULPHIDE AND GADOLINIUM MONOSULPHIDE. Peshev, P.; Bliznakov, G.; Toshev, A. (Inst. of General and Inorganic Chemistry, Sofia). J. Less-Common Metals, 14: 379-86(Apr. 1968).

Optimum conditions for the preparation of stoichiometric gadolinium sesquisulfide and gadolinium monosulfide according to the reactions $Gd_2O_3 + 3H_2S \rightarrow Gd_2S_3 + 3H_2O$ and $Gd_2O_3 + 2Gd_2S_3 + 3C \rightarrow 6GdS + 3CO$ were investigated. It was established that stoichiometric Gd_2S_3 is obtained at temperatures above 750°C. Gadolinium monosulfide was prepared by carrying out the second reaction in vacuo in two stages: i.e., the stoichiometric mixture of the three components was heat-treated at 1600°C for 2 to 3 hr, ground and pressed into pellets, then heat treatment of the pellets was carried out at 1700°C for 2 hr. The magnetic susceptibilities of Gd_2S_3 and GdS were measured and the effective magnetic moments were determined. The latter are close to the magnetic moment of the Gd^{3+} ion, which indicates the prevalence of ionic bonds in both sulfides. The dependence on temperature of the work function, φ, for cathodes of Gd_2S_3 and GdS was investigated. The conductivities of both sulfides were determined theoretically; Gd_2S_3 was deduced to possess a semiconductor, and GdS a metal, conductivity. (auth)

18788 THE ASSOCIATION OF HYDROXIDE ION WITH TRIS(ETHYLENEDIAMINE)COBALT(III) AND TRIS(ETHYLENEDIAMINE)CHROMIUM(III) CATIONS IN DIOXAN–WATER AND DIOXAN–DEUTERIUM OXIDE MIXTURES. Chan, S. C. (Univ. of Hong Kong). J. Chem. Soc., A, No. 12, 2103-6(1967).

The equilibrium constant K for the association of tris(ethylenediamine)-cobalt(III) and -chromium(III) cations with hydroxide ion was measured, mainly at 25° by following the change in ultraviolet extinction coefficients of the complexes as a function of hydroxide ion concentration. At constant ionic strength, the equilibrium constants calculated were independent of the concentration of the complex or of the wavelength of the light, and were affected only very slightly by changes in temperature. The value for the chromium complex was smaller than for cobalt, a finding which might be partly responsible for the difference in rates of base hydrolysis of halogeno-ammine cations of the two metals. In the presence of dioxan, the extent of association for both complexes was greater, the equilibrium constants varying exponentially with the dielectric constants of the solvent mixture. The effect of replacing water by deuterium oxide was negligible for the cobalt complex, but quite appreciable for the chromium(III) cation, where there was a two- to three-fold increase in the observed ion-pair association constants. Deuteration of the complex did not produce any noticeable effect. (auth) (UK)

18789 DEUTERIUM ISOTOPE EFFECT IN OCTAHEDRAL SUBSTITUTIONS. PART III. LIBERATION OF CHLORIDE IONS FROM SOME cis-CHLORO(AMINE)BIS(ETHYLENEDIAMINE)-COBALT(III) CATIONS IN NEUTRAL, ACIDIC, AND BASIC SOLUTIONS. Chan, S. C.; Leh, F. (Univ. of Hong Kong, China). J. Chem. Soc., A, No. 12, 2010-13(1967).

The rates of release of coordinated chlorine from various cis-

chloro(amine)bis(ethylenediamine)cobalt(III) cations in neutral, acidic, and basic deuterium oxide solutions are reported and compared with corresponding data for protium oxide solutions. The results are discussed in terms of the solvation of complex cations, the degree of bond-fission in the transition state, hyperconjugation, intramolecular electron-transfer, ligand deuteration, and specific hydrogen-bonding. Where the complex contains a unidentate ambient ligand with the idle nucleophilic site suitably spaced for the formation of a chelate ring of low strain with cobalt, the observed deuterium isotope effect on solvolysis conforms to an initial rate-determining internal attack. (auth) (UK)

18790 RADIOTHERMOLUMINESCENCE AND THE CRYSTALLINE CHARACTER OF ORGANIC MATERIALS. Nikol'skii, V. G. (Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR, 176: 132-4(Sept. 1, 1967). (In Russian).

Luminescence phenomena take place during the heating of organic materials when the crystal lattice is rearranged or amorphous compounds are devitrified; this makes it possible to use radiothermoluminescence in the study of structural transformation. This principle was used to evaluate the homogeneity of solid, crystalline organic materials, such as toluene, ethylbenzene, tetralin, vinyl acetate, and 1,1-dicyclohexyldodecane. These compounds liquefy when cooled rapidly to 77°K and crystallize when cooled slowly. The specimens were warmed up in silver-plated containers to a temperature 1 to 2° below the melting point and kept there for one-half hour. This resulted in the coarsening of the crystallites which became transparent or semitransparent. The specimens were irradiated at 77°K with 1.6-MeV electrons, at a dose of 1 MRAD. After irradiation they were heated in a cryostat, observing the luminescence by means of an electrophotometer. All specimens exhibited luminescence up to the melting point; the amorphous ones exhibited this phenomenon earlier, when reaching the devitrification range. The radiothermoluminescence method is considered applicable for the determination of phase homogeneity, crystallite dimensions, and the degree of crystallinity of solid organic materials. (TTT)

18791 KINETICS AND MECHANISMS OF HYDROLYSIS OF BORAZINE DERIVATIVES IN AQUEOUS DIOXANE. Yoshizaki, Tamotsu; Watanabe, Haruyuki; Nakagawa, Toshio (Shionogi and Co., Ltd., Osaka). Inorg. Chem., 7: 422-9(Mar. 1968).

The hydrolysis rates of B-tris(phenylethynyl)borazine derivatives were increased by the addition of acids and bases. The reaction was first order with respect to borazine as well as with respect to acid and base concentrations. The isotope effect and the solvent isotope effect on the hydrolysis rate were measured to elucidate the mechanism. The hydrolysis proceeded more rapidly in dioxane $-H_2O$ than in dioxane $-D_2O$ solution by a factor of 2.1 for hydrochloric acid catalyzed hydrolysis and by a factor of 1.70 for triethylamine-catalyzed hydrolysis. The activation energies $\Delta E^{\ddagger}$ for the acid- and amine-catalyzed hydrolyses are about 10 kcal/mole for all of the derivatives examined. On the basis of these data, a model of the transition state was proposed for the acid- and base-catalyzed hydrolyses, respectively. (auth)

18792 MAGNETIC SUSCEPTIBILITY OF THE $Pu(C_2O_4)_2.3H_2O$–$Th(C_2O_4)_2.2H_2O$ SYSTEM. Aminov, T. G.; Evdokimov, V. B.; Zelentsov, V. V.; Zakharova, F. A. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 175: 1309-11(Aug. 11, 1967). (In Russian).

Magnetic susceptibility measurements were made on the $Pu(C_2O_4) \cdot 3H_2O$–$Th(C_2O_4)_2 \cdot 2H_2O$ system in order to obtain definite data on the electron configuration of the tetravalent plutonium ion in its oxalate compound. The solution of $Pu(C_2O_4)_2 \cdot 3H_2O$ in the diamagnetic thorium oxalate were prepared by heating the mixed crystals of coprecipitated plutonium and thorium hexahydrates to 110°C. The magnetic susceptibility measurements were carried out at 79 to 300°K in helium atmosphere at 2 to 5 mm of Hg pressure. The results indicated that the Pu(IV) ion in the oxalate probably possesses a 5 f^4 configuration. The low value of the magnetic susceptibility is due to the fact that the ground level is not degenerate. (TTT)

18793 COPRECIPITATION OF TUNGSTEN WITH METAL HYDROXIDES. Plotnikov, V. I.; Kochetkov, V. L. (Inst. of Nuclear Physics, Alma-Ata, USSR). Zh. Neorg. Khim., 13: 203-6 (Jan. 1968). (In Russian).

The coprecipitation of tungsten with hydroxides of Be, Al, In, Ti, Cr, Fe, Zr, Y, Pb, Bi, Th, La, and Ce(IV) was investigated. It was found that the sorption capacity of the hydroxides studied with respect to tungsten ion increased from Be to Ce(IV). (tr-auth)

18794 INTERACTION OF THE PENTACHLORIDES OF TANTALUM AND NIOBIUM WITH THE CHLORIDES OF ELEMENTS OF THE FIFTH GROUP. Glistenko, N. I.; Chikanov, N. D. (Voronezh State Univ., USSR). Zh. Neorg. Khim., 13: 293-4 (Jan. 1968). (In Russian).

The binary systems $Ta(Nb)Cl_5-ECl_x$, where E represents p^{5+}, p^{3+}, Sb^{5+}, Sb^{3+}, Bi^{3+}, and V^{4+}, were investigated by differential thermal methods and visual examinations. The pentachlorides of Ta and Nb interact in the same manner with the chlorides studied. Ta and Nb pentachlorides form degenerate eutectics with the low-melting chlorides PCl_3, VCl_4, $SbCl_3$, and $SbCl_5$. With the comparatively high-melting $BiCl_3$ they form eutectics of the usual type. PCl_5, in contrast to $SbCl_5$, forms with $TaCl_5$ and $NbCl_5$ high-melting congruent compounds with the composition $TaPCl_{10}$ and $NbPCl_{10}$. It was assumed the $TaCl_5$ and $NbCl_5$ form a degenerate eutectic with $AsCl_3$. (tr-auth)

18795 TERNARY THENOYLTRIFLUOROACETONE COMPLEXES OF URANYL IONS WITH 1,10-PHENANTHROLINE OR 2,2'-DIPYRIDYL. Kononenko, L. I.; Burtnenko, L. M. (Inst. of General and Inorganic Chemistry, Kiev). Zh. Neorg. Khim., 13: 195-9(Jan. 1968). (In Russian).

The formation of ternary complexes of uranyl ions with thenoyltrifluoroacetone (TTA) and 1,10-phenanthroline(Phen) was investigated by spectrophotometric methods. It was established that in the complex compounds, extracted with benzene, the ratio UO_2: TTA : Phen is 1 : 2 : 1. Ternary complexes of uranyl ions with thenoyltrifluoroacetone and 1,10-phenanthroline or 2,2'-dipyridyl. (Dip) were separated. The analysis for their component concentrations showed that their composition agreed with the formulas $UO_2TTA_2 \cdot$ Phen and $UO_2TTA_2 \cdot$ Dip. It was found that the introduction of 1,10-phenanthroline into the UO_2TTA_2 molecule led to an increase in the degree of extraction of uranium with benzene. The uranyl ion in the ternary complex compounds with TTA and 1,10-phenanthroline in benzene solution fluoresces during irradiation with long-wave ultraviolet light because of the intramolecular energy transfer. (tr-auth)

18796 VAPORIZATION OF SOME RARE-EARTH DICARBIDES. Faircloth, R. L.; Flowers, R. H.; Pummery, F. C. W. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem., 30: 499-518(Feb. 1968). (AERE-R-5480).

Pure samples of LaC_2, CeC_2, NdC_2, SmC_2, and EuC_2 were synthesized from the elements, and equilibrium vapor pressures were measured in the temperature range from 1300 to 2400°K. Standard heats of formation for the dicarbides were derived. (auth) (UK)

18797 INFRARED SPECTRA AND STRUCTURE OF COMPOUNDS FORMED BY EXTRACTION OF HNCS AND U(VI) BY SOLUTIONS OF TRIOCTYLAMINE. Lipovskii, A. A.; Kuzina, M. G. Zh. Neorg. Khim., 13: 222-7(Jan. 1968). (In Russian).

By means of infrared spectroscopy, it was found that the thiocyanate of trioctylamine(TOA) represents an ion pair with hydrogen bonds of the type $N-H \ldots N$, in which the acceptor appears to be the nitrogen atom of the isothiocyanate group. The strengthening of these hydrogen bonds during dilution of the TOAHNCS solution in CCl_4, developing in the displacement of valence oscillation bands, νNH, in the area of lower wave number, was reflected in the oscillation spectrum of the anions in the form of displacement of valence oscillation bands, νCN. Solutions of TOA thiocyanate can extract HNCS molecules from aqueous solutions. The extraction of the acid was caused by the formation of hydrogen bonds with anions of trioctylamine salts. The examination of the infrared spectrum of the different thiocyanate complex compounds of uranyl ions led to the conclusion that uranyl pentathiocyanate is the extracted compound. (tr-auth)

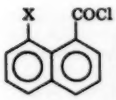
18798 SOLUBILITY OF LANTHANUM AND CERIUM IN THEIR FUSED TRICHLORIDES. Polyachenok, O. G. (Belorussian Inst. of Tech., Minsk). Zh. Neorg. Khim., 13: 200-2(Jan. 1968). (In Russian).

For verification of the literature data, the solubility of metallic lanthanum in its fused trichloride was determined at 950°C. The mean value (10.5 mole % La) agreed satisfactorily with previously reported results. Data available in the literature on the very high solubility of La and Ce at temperatures from 900 to 1000°C can apparently be explained by the contamination of the material with oxygen-containing compounds. (tr-auth)

18799 CONTRIBUTIONS OF NONBONDED INTERACTIONS TO SECONDARY KINETIC ISOTOPE EFFECTS. Papaioannou, Christos George. East Lansing, Mich., Michigan State Univ., 1967. 101p.

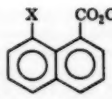
Thesis.

In order to assess the contribution of nonbonded interactions to secondary isotope effects and test the applicability of Bartell's model, a series of compounds of the general formula I and II were synthesized and their solvolytic rates were measured.



I

Ia X = H
Ib X = D
Ic X = CH_3
Id X = CD_3
Ie X = Br



II

IIa X = H
IIb X = D
IIc X = CH_3
IId X = CD_3

It was found that methyl 1-naphthoate (IIa) hydrolyzes in alkaline solution about 10^3 times faster than methyl 8-methyl-1-naphthoate (IIc). The ratio of the measured rate constants for the hydrolysis of 1-naphthoyl chloride (Ia), 8-bromo-1-naphthoyl chloride (Ie) and 8-methyl-1-naphthoyl chloride (Ic) in 95% acetone–water (w/w) was found to be 1:2.80:8.62 respectively. From this evidence and the isotope effects observed in the solvolysis of 1-naphthoyl chloride-8-d (Ib) and 8-methyl-d_3-1-naphthoyl chloride (Id), it was postulated that 8-methyl-1-naphthoyl chloride solvolyzed by a limiting S_N1 mechanism while 1-naphthoyl chloride solvolyzed most probably by a mixed (S_N1-S_N2) mechanism. There was no significant isotope effect in the solvolysis of 1-naphthoyl chloride-8-d, most likely because the reaction took place by a mixed mechanism. In the case of 8-methyl-d_3-1-naphthoyl chloride a normal isotope effect of 1.03 and 1.17 was observed in 95% acetone–water (w/w) at room temperatures and 75.23% acetone–water (w/w) at low temperatures (−20 to −34°C) respectively. The activation parameters found at low temperatures for the solvolysis of 8-methyl-1-naphthoyl chloride and its 8-d_3 analog showed that the observed isotope effect was the result of a normal isotope effect due to an enthalpy of activation difference, which was about equal to that calculated from Bartell's model, and an inverse isotope effect due to an entropy of activation difference. In the alkaline hydrolysis of methyl 1-naphthoate-8-d no significant isotope effect was found. It was concluded that nonbonded interactions can be of primary importance with regard to the origin of secondary isotope effects. Bartell's model gave reasonable estimates of these effects. (Diss. Abstr.)

18800 AN INVESTIGATION OF THE NITRONIUMTETRAFLUOBORATE NITRATION OF BENZENE, ALKYLBENZENE, AND HALOBENZENE IN TETRAMETHYLENESULFONE SOLUTION AND THERMAL REARRANGEMENT OF ISOQUINOLYL ALLYL ETHERS. Win, Htain. Buffalo, State Univ. of New York, 1967. 160p.

Thesis.

Substituent effects on the rate of nitroniumtetrafluoroborate nitration of benzene, toluene, fluorobenzene, chlorobenzene, and bromobenzene in tetramethylenesulfone were studied by competitively nitrating 2-component mixtures (such as toluene–benzene, benzene–chlorobenzene, toluene–chlorobenzene, benzene–fluorobenzene, fluorobenzene–chlorobenzene, chlorobenzene–bromobenzene and toluene–fluorobenzene), and a 4-component mixture (benzene–toluene–fluorobenzene–chlorobenzene). The failure to reproduce the binary rate ratio values from the 4-component value, suggests that the reaction system is not kinetically well-behaved. Kinetic isotope effects on the nitroniumtetrafluoroborate nitration of chlorobenzene in tetramethylenesulfone were studied by competitively nitrating mixtures of bromobenzene–chlorobenzene, bromobenzene–p-chlorobenzene-d, and bromobenzene–m-chlorobenzene-d. The kinetic isotope effects observed were 7 to 10% smaller than previously reported results. In either case, the magnitude of the kinetic isotope effects was too small to attach any significance regarding the mechanism of the nitration. The relative rate constants were obtained by analyses of the reaction mixtures. 3-Alloxyisoquinoline, 3-allyl-4-methylisoquinoline, and 1-allyloxyisoquinoline were thermally rearranged. Heating 3-allyloxyisoquinoline in 2-methylnaphthalene for 1 hour at 190° gave only 4-allyl-3-hydroxyisoquinoline (56%). Heating 3-allyl-oxy-4-methylisoquinoline in 2-methylnaphthalene for 1 hour at 190° resulted in no rearrangement; decomposition resulted at high temperatures. Thermal rearrangement of 1-allyloxyisoquinoline near at 250° for 5 hours gave only 2-allyl-1(2H)-isoquinolone (94%). Studies in the thermal rearrangements of isoquinolyl allyl ethers led to the conclusion that the nature of the annular atoms adjacent to the allyloxy-substituted carbon in N-heteroaromatic allyl ethers does not play a significant role in influencing the direction of the allyl group migration. An attempt was made to arrive at some suitable reactivity index such as charge density, localization energy, etc., which may correlate with the rearrangement product distribution in ortho-Claisen rearrangement. A semiempirical MO method (IEHT) was developed. (TSS) (Diss. Abstr.)

18801 NUCLEAR MAGNETIC RESONANCE STUDIES OF 4-SUBSTITUTED PYRIMIDINES AND REACTIONS OF BENZENE WITH PYRIDONES. Wright, George Edward Blake. Urbana, Ill., Univ. of Illinois at the Medical Center, 1967. 134p.

Thesis.

The nuclear magnetic resonance spectral parameters of a number of 4-substituted pyrimidines, pyrimidones indexed as pyrimidinones and pyrimidthiones indexes as pyrimidinethiones were obtained in dimethyl sulfoxide solution. From an analysis of their chemical shifts and coupling constants 1- and 3-alkyl-4-pyrimidones were formed to possess less aromatic character than 4-methoxypyrimidine. Furthermore, the data indicate that 1-alkyl-4-pyrimidones possess even less aromatic character than the 3-alkyl analogs, and that 4-pyrimidone prefers the 3-H form to the 1-H form in this medium. An analysis of the sulfur analogs of these compounds gave similar results for this series. The deuterochlorides of 4-methoxypyrimidine, 4-pyrimidone 1-methyl-4-pyrimidone, and 3-methyl-4-pyrimidone showed large chemical shift and coupling constant changes with respect to the corresponding free bases. The spectra of these salts and two quarternary 4-oxopyrimidinium salts suggested that they possess common π-electron distributions. In both the quarternary salts and the N-methyl deuterochlorides, long-range coupling of H-2 with the N-methyl groups was observed (0.3 to 0.5 cps), similar to that in dimethylformamide. Deuterium exchange of H-2 of the 4-pyrimidones and thiones in deuterium oxide at 90° was studied. Kinetic data were determined for this process by following the decrease in NMR intensity of H-2 with time. Furthermore, this exchange was not susceptible to catalysis by acids or bases. The rates of exchange of H-2 of 4-pyrimidone were determined at 70°, 80°, and 90° and the data used to calculate an activation energy ($\Delta E_{act.}$ = 23.4 kcal) and an activation entropy ($\Delta S_{act.}$ = −12.4 cal/mole). The mechanism proposed involves a four-center transition state between the pyrimidone and the deuterium oxide molecule. The pyrimidone quarternary salts also exchanged H-2, but this reaction was found to be base-catalyzed and is thought to proceed via a yield intermediate. Reactions of benzyne with pyridones were also studied and the products isolated. (TSS) (Diss. Abstr.)

18802 PLASTIC SCINTILLATORS. Sandler, Stanley R.; Tsou, Kwan C.; Dannin, Jordan E. (to Borden Co.). U. S. Patent 3,356,616. Filed Mar. 5, 1964.

A scintillator is made up of a primary absorber and a primary fluor in a clear plastic solution. The primary absorber is a copolymer of a monomer of the formula $R_3-M-C_6H_4-CR'=CR''_2$ in which M is Sn, R is selected from the group consisting of C_{1-6} alkyls and alkenyls and C_{6-10} aryl, arylalkyl, alkylaryl, acryloxyaryl groups, and R′ and R″ are monovalent components selected from the group consisting of H and C_{1-6} alkyls and alkenyls, with a comonomer of the same formula except that M is Pb, in the proportion of 10 to 90 parts of one of the comonomers for 100 parts total of the copolymer. (Offic. Gaz.) (TSS)

Radiation and Nuclear Chemistry

Refer also to abstracts 18737, 18905, 20089, and 20095.

18803 (AECL-3044) THE CANADIAN APPROACH TO CHEAPER HEAVY WATER (1967). Bancroft, A. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 1968. 45p. Dep. CFSTI. CAN $1.50.

Canadian heavy water production capacity will be 800 tons/year by 1970 in two plants in Nova Scotia using the hydrogen sulfide–water exchange (GS) process. Since forecast demands indicate the likelihood of additional plant capacity by 1975 Atomic Energy of Canada Limited is directing development effort at new processes to reduce the cost in future plants. There is no established competitor to the GS process, but there is enough data for ammonia–hydrogen exchange to allow a fairly detailed cost study involving only two major assumptions. A 60 to 70 ton/year unit using ammonia synthetic gas as feed may be attractive if the deuterium content of the feed is above 120 ppM and if an efficient gas–liquid contactor can be developed. Studies are under way at CRNL and Canadian universities and industries to confirm these assumptions and to examine a number of other aspects of deuterium–hydrogen separation processes. (auth)

18804 (ANL-7400) TABLES FOR THE EVALUATION OF DECAY CURVES OF A CHEMICAL SPECIES UNDERGOING SIMULTANEOUS FIRST- AND SECOND-ORDER DECAY. Schmidt, Klaus H. (Argonne National Lab., Ill.). Dec. 1967. Contract W-31-109-eng-38. 17p. Dep. CFSTI.

Tables were computed to facilitate the determination of the first- and second-order components of the decay curve of a chemical species from two measured half-lives. (auth)

18805 (COO-913-23) REACTION OF BENZENE WITH BROMOBENZENE AND 4-BROMOBIPHENYL: POSSIBLE APPLICATION AS A HIGH SENSITIVITY DOSIMETER. Hirayama,

Fumio (Minnesota Univ., Minneapolis). Mar. 5, 1968. Contract AT(11-1)-913. 11p. Dep. CFSTI.

To develop a more useful dosimeter, studies were made on the photochemical reaction between benzene and 4-bromobiphenyl. Both ultraviolet light and gamma radiation were used as excitation sources. At low doses the G-value for production of p-terphenyl was calculated to be 0.92. If this G-value persists to lower doses, the reaction can be used to determine doses as low as 6.5×10^{13} eV/g (1 rad). (M.C.G.)

18806 (COO-1385-21) RADICALS IN IRRADIATED CRYSTALS STUDIED BY ESR SPECTROSCOPY. Technical Report, January 1–December 31, 1967. (Michigan State Univ., East Lansing). Contract AT(11-1)-1385. 11p. Dep. CFSTI.

Developments are reported for studies on: trifluoromethyl and other radicals in irradiated single crystals of trifluoroacetamide; ESR study of CF_3COO^- radicals in irradiated single crystals of sodium chlorodifluoroacetate; effects of crystal structure on production of radicals in irradiated crystals; ESR studies of radicals in irradiated crystals; trichloromethyl radical in irradiated trichloroacetamide; conversion of $\cdot CH_3$ to $\cdot CH_2COO^-$ in irradiated sodium acetate crystals; irradiated polycrystalline fluorocarbon derivatives; radicals in irradiated amides; radicals trapped in irradiated clathrates; radicals in fluoroacetamide irradiated at 77°K; ESR spectra of octamethylnaphthalene and hexamethylnaphthalene cations; computer analysis of NMR spectra; chlorine quadrupole resonance study of some molecular adducts of phosphorus oxychloride; rhenium pure quadrupole resonance spectrum of potassium perrhenate; NQR study of charge transfer complexes; and point-charge calculations of electric field gradients in crystals. (P.C.H.)

18807 (EUR-3731) DEVELOPPEMENT DE METHODES DE MARQUAGE DE COMPOSES ORGANIQUES. RAPPORT FINAL. (Development of Methods for Labelled Organic Compounds. Final Report). Adloff, J. P.; Bertrand, R.; Gerardin, C.; Paulus, J. M. (Centre National de la Recherche Scientifique, Strasbourgh (France). Centre de Recherches Nucleaires). Jan. 1968. Contract 076-64-3 RISF. 62p. (In French). Dep.

Development of unconventional labeling methods are described. The first method is labeling of butane under the impact of tritium ions in the energy range between 3 eV and 6000 eV. A mass spectrometer was designed to produce tritium ions with controlled energy and to study the interaction of these ions with gaseous targets. The results of the irradiation of butane are presented, as a function of the particle energy and the pressure of the target. The incorporation of tritium into butane was low and did not exceed 4% in the best conditions. The second method is electric discharge-induced labeling. Results of a high frequency electric discharge in methane-^{14}C alone and admixed with halogen vapors are presented. It is shown that the synthesis led in several seconds to the formation of higher hydrocarbons and halocarbons with the same specific activity as the methane. The third method is tritiation of hydrocarbons and their derivatives by exchange labeling with the complex of tritiated phosphoric acid and boron trifluoride. (auth)

18808 (INR-841/XVII/C) RADIACYJNE SZCZEPIENIE STYRENU NA FOLII ORAZ KORDZIE Z POLITEREFTALANU ETYLENOWEGO. (Radiation Induced Copolymerization of Styrene With Polyester Foil and Cord). Burhak, Zofia; Zielinski, Waclaw (Institute of Nuclear Research, Warsaw (Poland)). 1967. 12p. (In Polish). Dep. CFSTI.

Graft-copolymerization of styrene with commercially available cord and polyester foil was achieved using a radiation technique. Strength and adhesive properties of copolymers were estimated. The influence of temperature, solvents concentration, and absorbed dose on the effectiveness of the grafting was determined. Modified cord exhibited a decrease in strength but a small increase of adhesiveness to the rubber. (auth)

18809 (NP-17282) THE REACTION BETWEEN CARBON AND CARBON DIOXIDE UNDER IRRADIATION. Report No. 13,506C. Copestake, T. B.; Corney, N. S. (General Electric Co. Ltd., Wembley (England). Research Labs.). Jan. 5, 1960. 40p. (NPCC/MWP(G)-75GCM/UK/1). Dep.

The reaction between carbon and carbon dioxide under pile and γ irradiation was studied in sealed silica bulbs. The following conclusions were made: (a) irradiation-promoted degassing was not found to play an important part in the reaction. (b) The rate of carbon monoxide production decreased with increasing radiation dose and the initial rate of carbon monoxide production depended on the amount and geometry of the carbon and the amount and pressure of the carbon dioxide but not markedly on the nature of the carbon. (c) The utilization of gas irradiated within the pores was compared with that irradiated outside the geometrical surface for two sizes of graphite specimens. Gas irradiated sufficiently remotely from the carbon was utilized ineffectively. (d) Irradiation at 500°C indicated that the radioinduced reaction can have only a small temperature coefficient. (e) An experiment relying on electrically-heated carbon filaments irradiated in a carbon dioxide atmosphere failed to detect gasification of the carbon. (f) Carbon monoxide decomposed under irradiation to give carbon dioxide and a solid, the properties of which depend on the temperature of formation. (auth)

18810 (RRL-2310-223) QUARTERLY REPORT [ON RADIATION RESEARCH], OCTOBER 1–DECEMBER 31, 1967. Fundamental Research No. 6041. (Mellon Inst., Pittsburgh, Pa. Radiation Research Labs.). Jan. 24, 1967. Contract AT(30-1)-2310. 15p. Dep. CFSTI.

Research progress is reported on: electron decay in pulse-irradiated gases, pulse radiolytic studies of ions in organic media, solvated electrons spectra in viscous alkaline aqueous solutions, electron scavenging in irradiated cyclohexane solutions, effect of electron scavengers on the reaction of the cyclohexane positive ion with cyclopropane, mass-spectrometric investigations of the $N_2 + CH_4$ discharge flow systems, intermediates in nucleophilic aromatic substitutions, and radioinduced hydroxylation of fluorobenzene in dilute aqueous solutions. (M.C.G.)

18811 (TID-4005(Pt.2A)(3rd Ed.)) SUMMARIES OF THE USAEC BASIC RESEARCH PROGRAM IN CHEMISTRY (OFF-SITE). (Division of Research (AEC), Washington, D. C.). Apr. 1968. 186p. Dep. CFSTI.

The summaries are presented under the following headings: heavy-element chemistry; nuclear chemistry; radiation, photo, and hot-atom chemistry; structural and theoretical chemistry; isotope-effects chemistry; high-temperature chemistry; inorganic chemistry; physical chemistry; analytical chemistry; separations and geochemistry; and nuclear-engineering chemistry. Corporate author, investigator, and subject indexes are included. (M.C.G.)

18812 RADIO-CHEMICAL TRANSFORMATION OF SOLID GLUCOSE EXPOSED TO ^{60}Co γ RADIATION. Ibragimov, A. P.; Sultanov, A.; Sanaev, B.; Tuichiev, A. V. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 4, 36-8(1967). (In Russian).

Studies were made with D(+)-glucose preliminarily dried at 60°C in a vacuum (10^{-3} mm Hg) and irradiated in both an open and closed flask with ^{60}Co γ rays with 8×10^{15} eV/cm^3 sec and 10^5 to 10^8 RAD dose. The yield of hydrogen peroxide (formed by dissolution of the irradiated specimen in water) was determined for various doses of irradiation. A curve of the free radical accumulation in irradiated glucose was constructed as a function of the dose. Comparative studies of glucose irradiated in air showed that in vacuum-irradiated specimens the yield of radicals was ~20% higher. The content of hydrogen peroxide in irradiated glucose increased with an increase of the dose and a decrease in pH. The concentration of carbonyl compounds from the irradiated glucose also increased with the increase of radiation dose. (R.V.J.)

18813 RADIOLYSIS OF n-HEXENES. Brash, J. L.; Golub, M. A. (Stanford Research Inst., Menlo Park, Calif.). Can. J. Chem., 46: 593-8(1968).

The radiolysis of hexene-1, hexene-2, and hexene-3 at room temperature was studied with particular emphasis on the mechanisms leading to dimer formation. The structures of the hexene dimers were investigated by means of infrared and nmr spectroscopy. The dimers from hexene-1, -2, and -3 had average unsaturations of 1.0, 1.2, and 1.2 double bonds/molecule, respectively, and were formed with G-values of 4.6, 4.6, and 4.1, respectively. The dimerization of hexene-1 could be interpreted as proceeding, in part, through an ionic mechanism leading exclusively to monoolefinic structures, and in part through another ionic mechanism leading to a mixture of saturated, monoolefinic, and diolefinic structures. Hexene-2 and hexene-3 were found not to dimerize by the first of these ionic mechanisms, but largely by the second mechanism, along with some contribution from an exclusively radical process. The hexene-1 results are in qualitative accord with those previously reported for this olefin, while the differences noted here between this terminal olefin and the non-terminal olefins, hexene-2 and hexene-3, are qualitatively similar to the differences reported previously for butene-1 and butene-2. (auth)

18814 STUDY FOR A RADIATION CHEMISTRY RESEARCH CENTRE. Hummel, D. O.; Schneider, Ch.; Ley, G. (Univ., Cologne). Kerntechnik, 10: 32-45(Jan. 1968). (In German).

Planning of a research facility designed to study radioinduced processes of technical interest is reported. Reactions with G-values greater than 50 may be developed from laboratory to pilot-plant scale. Details are given of the organization, design,

and set-up of the irradiation facility, the technical block, the laboratories, and the equipment. Capital cost and yearly operating budget are estimated. (auth)

18815 REACTIONS OF THE HYDRATED ELECTRON IN ALKALINE SOLUTION. Klein, Nathan; Trumbore, Conrad N.; Fanning, James E. Jr.; Warner, John W. (Army Nuclear Defense Lab., Edgewood Arsenal, Md. Univ. of Delaware, Newark). J. Phys. Chem., 72: 880-5(Mar. 1968).

An investigation of chemical reactions taking place in aqueous solutions during and immediately after an x-radiation pulse was carried out. Equipment with resolving time in the nanosecond range was assembled to measure optical absorption as a function of time using 6328-Å light. The hydrated electron, e^-_{aq}, was produced in solutions of Na_2CO_3, $Ba(OH)_2$, H_2SO_4, and $HClO_4$ by a 3-kRad, 50-nsec x-ray pulse from an electron accelerator. No evidence for nonhomogeneous distribution of e^-_{aq} was obtained in the time frame investigated. In air-free alkaline solution, an extremely rapid decay of the e^-_{aq} absorption was observed. This decay was observed for approximately 0.5 μsec after an x-ray pulse. The very fast disappearance was quenched when the solutions contained an excess of structure-breaking ions over structure makers. It is postulated that the observed decay was due to reaction of e^-_{aq} with H_2O^+. (auth)

18816 GAS-PHASE RADIOLYSIS OF BENZENE. Hentz, Robert R.; Rzad, Stefan J. (Univ. of Notre Dame, Ind.). J. Phys. Chem., 72: 1027-31(Mar. 1968). (COO-38-542).

The γ-radiolysis of benzene vapor was studied at room temperature as a function of pressure (5 to 80 torr), dose, dose rate, and added NO and N_2O. $G(-C_6H_6)$ and the yields and variety of ring-fragmentation products were considerably greater than in radiolysis of the liquid. At pressures greater than ~60 torr, product yields were independent of pressure. At 66 torr, values of $G(H_2) = 0.11$ and $G(C_2H_2) = 0.63$ were obtained, which were independent of dose, dose rate, and the presence of NO or N_2O. It was concluded that, at >60 torr, H_2 and C_2H_2 were not formed via free-radical or ion-neutralization reactions, but were formed by molecular elimination from either superexcited states or ion–molecule reactions of $C_6H_7^+$ with C_6H_6 or both. G values of the following products also were studied: CH_4, C_2H_4, propadiene, butadiyne, cyclohexene, cyclohexadienes, biphenyl, and dihydrobiphenyls. The yields of all such products showed in addition to a pressure dependence below ~60 torr, a dependence on certain of the other radiolysis variables; free radicals or secondary ions or both were involved at some stage in their formation. At the lowest dose studied, except for G(biphenyl) = 0.17, all such products were formed with G < 0.1. At a total pressure of 66 torr, radiolysis of benzene in the presence of N_2O yielded N_2 and phenol in a 2:1 ratio; $G(N_2) = 13.3$ at 10 mole % N_2O appeared to require some kind of short-chain mechanism. (auth)

18817 RADICAL YIELD IN γ-IRRADIATED AQUEOUS ALKALINE SOLUTIONS OF FREMY'S SALT. Rakintzis, N. Th. (Democritos Nuclear Research Center, Athens); Stein, Gabriel. J. Phys. Chem., 72: 1011-13(Mar. 1968).

Using deaerated aqueous solutions of $ON(SO_3)_2^{3-}$ at pH 10 to 11, the total radical yield was determined in γ-irradiated solutions, $G_{(H+e+OH)} = 6.1$. (auth)

18818 YIELDS OF THE PRIMARY REDUCING SPECIES IN THE RADIOLYSIS OF LIQUID ETHANOL. Russell, J. C.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Phys. Chem., 72: 816-21(Mar. 1968).

The effects of high temperature, acid, and nitrous oxide on the radiolysis of liquid ethanol were studied. The results indicated that at all temperatures, reaction between added hydrogen chloride and the ethanol took place, and the resulting ethyl chloride seriously complicated the study of acid effects. In the light of the new results and better understanding of the effects of acid, previously published values of $G(N_2)$ from ethanolic nitrous oxide solutions were reinterpreted in terms of the nonhomogeneous kinetics model. The new interpretation gave $G(H) = 2.2$, $G(e^-_{solv})_{fi} = 1.5$, and G(geminate neutralization) = 2.5. The unknown hydrogen precursors X and Y with yields $G(X) = 0.8$ and $G(Y) = 1.1$ were again found (cf. J. C. Russell and G. R. Freeman, J. Phys. Chem., 71: 755(1967)). (auth)

18819 REACTIONS OF THE PRIMARY REDUCING SPECIES IN THE RADIOLYSIS OF LIQUID 2-PROPANOL. Russell, J. C.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Phys. Chem., 72: 808-15(Mar. 1968).

A study was made of the effects of temperature, acid, and nitrous oxide on the yield of hydrogen in the radiolysis of 2-propanol. The yields of free-ion solvated electrons and those that undergo geminate neutralization were calculated to be $G(e^-_{solv})_{fi} = 1.2$ (at 25°C) and G(geminate neutralization) = 2.8 (at 25°C). The fate of a portion of the electron yield equivalent to $G(e^-_{solv}) = 1.9$ was temperature dependent. At low temperatures, there was no hydrogen produced from this portion of the solvated electron yield. At temperatures above 140°C all of these electrons gave rise to hydrogen. The results of electron scavenging reactions by nitrous oxide were tested against a nonhomogeneous kinetics mechanism, with moderate success. Secondary reactions involving nitrous oxide produced large yields of nitrogen at high temperatures and high nitrous oxide concentrations. (auth)

18820 PHOTOLYSIS AND RADIOLYSIS OF CO_2: FUNDAMENTAL RESEARCH WORK DONE AT SACLAY AND ELSEWHERE. Hering, H. Bull. Inform. Sci. Tech. (Paris), No. 121, 69-82(Dec. 1967). (In French).

Oxygen losses commonly observed during photolysis of CO_2 are shown to be due to capture by the impurities existing on the walls. The oxygen carrier is probably CO_3. Photolysis of CO_2 gives CO vibrationally excited by one or two quanta. Recombination with the oxygen atom formed in the ^1D state requires vibrational deexcitation, after which it takes place by double collision, with a collision efficiency of about 0.1 at 3 torr. An apparatus built for pulsed radiolysis studies in gases is described. In CO_2, CO, CH_4 an absorption due to carbon atoms in ^1S state was seen. The long lifetime of this species in CO_2 enabled its reaction rates with H_2, O_2, CO, CH_4, C_2H_6 to be measured. CO_2 radiolysis gives a large yield of $O(^3P)$, leading to a plausible explanation for the poor efficiency of CO as a protecting agent for the graphite against attack by CO_2 under pile radiation. (auth)

18821 POLYMERIZATION OF β-(2-FURYL)ACROLEIN IN SOLUTION BY IONIZING RADIATION. Yamakita, Hiromi; Hyakawa, Kiyoshi (Government Industrial Research Inst., Nagoya, Japan). J. Polym. Sci., Part A-1, 5: 33219-22(Dec. 1967).

The gamma-radioinduced polymerization of β-(2-furyl)acrolein (2-furanacrolein) in various solvents was accomplished at dose rates of 6.5 to 18.4×10^4R/hr at 25 or 28°C. The solvents included dioxane, 3-pentanone, 2-methyl-1-propanol, 1-chlorobutane, dichloromethane, chloroform, and carbon tetrachloride. Properties of the various polymers are discussed. (J.G.B.)

18822 PARAMAGNETIC RESONANCE OF γ-IRRADIATED SELENIOUS ACID. Jardine, L.; O'Reilly, D. E.; Tsang, Tung (Argonne National Lab., Ill.). J. Chem. Phys., 48: 1417-19(Feb. 1, 1968).

Paramagnetic resonance studies are described in which the γ irradiation of selenious acid, H_2SeO_3, is believed to give rise to $HSeO_2$ radicals. Principal values of the g tensor and ^{77}Se hyperfine coupling tensor along with the transformation matrix between the crystal and principal axes are given. The transformation matrices for the g factor and hyperfine coupling tensors were found to be identical within experimental errors. The isotropic proton hyperfine coupling constant is 22 ± Mc/sec with a maximum anisotropy of ±50% observed in the rotation patterns. (P.C.H.)

18823 MECHANISM OF HYDROGEN FORMATION BY ELECTRONS IN X- OR γ-IRRADIATED GASEOUS HCl. Davidow, R. S.; Armstrong, D. A. (Univ. of Calgary, Alberta). J. Chem. Phys., 48: 1235-41(Feb. 1, 1968).

Studies of the effects of Cl_2 and SF_6 on the production of hydrogen from the x or γ radiolysis of gaseous HCl indicated that 2.5 ± 0.1 electrons per 100 eV form an intermediate H_α, which is not a thermal hydrogen atom. The remainder of the total yield of 4.0 electrons per 100 eV give rise to thermal hydrogen atoms. The results can be explained satisfactorily on the basis of the electron-capture reactions given, where the sum of k_{4a} and k_{4c} lies in the range 5×10^{-32} to 2.6×10^{-30} ml^3 molecule$^{-2} \cdot$ sec^{-1}. H_α is taken to be a clustered form of HCl^- which either produces molecular hydrogen in further reactions with HCl molecules, or is scavenged by Cl_2. The rate constant ratio $k_{H\alpha+HCl}/k_{H\alpha+Cl_2}$ was 8×10^{-6} at −77° ± 2°C and $1.2 \pm 0.3 \times 10^{-3}$ at 1 ± 1°C. Chlorine competes with HCl for the thermal hydrogen atoms formed as well as for H_α, and at −77 ± 2°C k_{H+HCl}/k_{H+Cl_2} was found to have a value of $2.6 \pm 0.7 \times 10^{-3}$, in good agreement with the data of others. SF_6 cannot scavenge thermal hydrogen atoms and its effects are attributable entirely to a competition with HCl for electrons. (auth)

18824 CHARGE SCAVENGING VS HYDROGEN ATOM SCAVENGING IN THE RADIOLYSIS OF LIQUID SATURATED HYDROCARBONS. Robinson, M. G.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Chem. Phys., 48: 983-9(Feb. 1, 1968).

The nitrogen and hydrogen yields from the γ radiolysis of solutions of nitrous oxide in various saturated hydrocarbons were measured. The nitrogen yields were nearly the same in all hydrocarbons, but the amounts of decrease in the hydrogen yields caused by the nitrous oxide varied markedly. The results support the suggestion that nitrous oxide reacts with electrons rather than hydrocarbons, but indicate that some nitrogen is also formed by

another reaction and that all electrons do not eventually lead to hydrogen formation during the radiolysis of the pure hydrocarbon. The gaseous product yields from binary cyclohexane solutions of nitrous oxide and of propylene were subjected to kinetic analysis according to several models. It was concluded that the decrease in hydrogen yield caused by nitrous oxide and by propylene can be quantitatively interpreted in terms of interactions between the solutes and the charged intermediates. This offers an alternative to the hydrogen atom scavenging mechanism that has usually been assumed in the past for propylene. Although carbon dioxide and propylene do not attach electrons in the gas phase, they appear to do so in liquid alkanes. Propylene is a somewhat less efficient scavenger than is nitrous oxide. (auth)

18825 SYNTHESIS AND PROPERTIES OF POLYIMIDAZOPYRROLONES. Bell, Vernon L.; Jewell, Robert A. (Langley Research Center, Hampton, Va.). J. Polym. Sci., Part A-1, 5: 3043-60 (Dec. 1967).

The preparation of polyimidazopyrrolones by three general synthetic methods was studied. The effects of structure, conversion temperature, and conversion environment were determined. The polyimidazopyrrolones were found to retain useful mechanical properties at elevated temperatures, after severe chemical treatment, and after unusually high exposure to ionizing radiation. Thermogravimetric analysis of the polymers indicated the effect of structure on oxidative stability was relatively minor; furthermore, the relative stabilities of a series of eight polymers in air were not directly comparable to the order of stability in a vacuum environment. (auth)

18826 γ-RADIOLYSIS OF CYCLOHEXANE WITH SCAVENGERS. III. PERFLUOROCARBONS AS ELECTRON SCAVENGERS. Sagert, N. H. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Can. J. Chem., 46: 95-9(Jan. 1968). (AECL-2982).

The room-temperature, liquid-phase radiolysis of cyclohexane in the presence of three solutes, perfluorocyclohexane (PCH), perfluoromethylcyclohexane (PMCH), and perfluorocyclobutane (PCB) were examined. All decreased the hydrogen yield from 5.6 to 2.6 G units by capturing electrons. However, with PMCH and PCB the yields of cyclohexene and bicyclohexyl were not decreased as much as the hydrogen yield and with PCH, dimer and olefin yields were increased. Furthermore, large yields of monohydrofluorocarbon (e.g., undecafluorocyclohexane) were produced, indicating that a carbon–fluorine bond was broken. It was concluded that electron capture by these fluorocarbon compounds causes dissociation; possible mechanisms are discussed, but it was not possible to reach a clear conclusion on the basis of the results. The radiolysis of homogeneous solid solutions of these solutes at 77°K was also studied, but only PMCH was studied in detail. Under these conditions there was no evidence for dissociative electron capture and apparently the combination of solute anion and hydrocarbon cation on warming did not lead to bond breaking. (auth) (Canada)

18827 THE RADIOLYSIS OF ETHANOL. VI. HYDROGEN PRECURSORS AT -196°C. Fletcher, J. W.; Freeman, G. R. (Univ. of Alberta, Edmonton). Can. J. Chem., 45: 635-40 (Mar. 15, 1967).

Reactions of trapped (or solvated) electrons in solid ethanol were studied. The following reactions occur at –196°C: $e^-_{solv} + h\nu$ ($\lambda > 5{,}200$ Å) → H + $C_2H_5O^-$; e^-_{solv} → H + $C_2H_5O^-$; and, e^- + $C_2H_5OH_2^+$ → H + C_2H_5OH. The activation energy of the second reaction was roughly 5 kcal/mole. The third reaction occurred with electrons that had not yet been trapped by the medium. Hydrogen atoms appeared to be able to abstract from ethanol and to add to propylene at –196°C. (auth)

18828 REACTION OF BORON CARBIDE WITH OXYGEN AND THE EFFECT OF PREIRRADIATION IN A NUCLEAR REACTOR. Dominey, D. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc., A, No. 3, 712-16(1968).

The kinetics of the oxidation of boron carbide between 503 and 528°C were studied by continuous measurement of weight change. The rate of oxidation reached a maximum at about 12% weight increase, and this was maintained up to about 35% weight increase; the rate then decreased, the weight increase becoming proportional to the square root of time. At this stage the rate was controlled by a diffusion process. The activation energies for the initial and maximum rates were 37.2 (±1.5) and 39.9 (±0.5) kcal/mole, respectively. Preirradiation of the boron carbide in BEPO enhanced the subsequent rate of oxidation. The initial acceleration of the reaction rate is attributed to splitting of crystals by oxidation along grain boundaries. Preirradiated crystals are more easily split than unirradiated crystals. (auth) (UK)

18829 GAMMA-INITIATED CHLORINATION OF METHANE. Werezak, G. N.; Hodgins, J. W. (McMaster Univ., Hamilton, Ont.). Can. J. Chem. Eng., 46: 41-8(Feb. 1968).

Gamma radiation has been used to initiate the gas phase reaction between chlorine and methane. The products consist of hydrogen chloride, and the four chlorinated methanes, in yields depending on the experimental conditions. Experiments were conducted over a range of temperatures, pressures, concentrations, and adsorbed doses. G-values as high as 1.2×10^6 were found, indicating the formation of a chain reacting system. Two hypothetical reactor models were used to obtain an estimate of the energy cost of the process. On the basis of the reactor models studied, a one-pass gamma reactor appears uneconomical for the production of carbon tetrachloride, but the energy cost for methyl chloride production is less than one percent of the product value. (auth)

18830 VALENCE DISTRIBUTION OF RADIOPHOSPHORUS IN POTASSIUM CHLORIDE SINGLE CRYSTALS. PART 1. INITIAL DISTRIBUTION. Baptista, J. L.; Newton, G. W. A.; Robinson, V. J. (Univ. of Manchester, Eng.). Trans. Faraday Soc., 64: 456-61(Feb. 1968).

The importance of crystal purity and perfection in determining the oxidation state of ^{32}P atoms in KCl was investigated. The ^{32}P was produced by the reaction $^{35}Cl(n,\alpha)^{32}P$, using reactor neutrons. In pure single crystals most of the ^{32}P appeared in the hypophosphite [P(I)] fraction on dissolution, but crystals containing OH^- ion or (CO_3 + CO_3^{2-}) impurity showed an increase in the phosphite [P(III)] and phosphate [P(V)] fractions at the expense of P(I). Introduction of defects either by crushing or quenching prior to irradiation also increased the oxidized fractions. A mechanism of oxidation for crystals with oxygen-containing impurities is proposed; this involves formation of a short-lived, deep electron trap, possibly an O-atom, by gamma radiolysis of the impurity. (auth) (UK)

18831 VALENCE DISTRIBUTION OF RADIOPHOSPHORUS IN POTASSIUM CHLORIDE SINGLE CRYSTALS. PART 2. EFFECT OF THERMAL ANNEALING. Baptista, J. L.; Newton, G. W. A.; Robinson, V. J. (Univ. of Manchester, Eng.). Trans. Faraday Soc., 64: 462-8(Feb. 1968).

Results are given of thermal annealing experiments on ^{32}P, produced by the reaction $^{35}Cl(n,\alpha)^{32}P$, in pure single crystals of KCl. No effect occurred until temperatures of about 150°C were reached. Above this temperature annealing caused only oxidation, and eventually all the ^{32}P appeared in the phosphate fraction on dissolution. Attempts were made to find activation energies for the oxidation processes; the values obtained are compared with values obtained by other workers. A mechanism is proposed for the oxidations, involving cation diffusion as the rate-controlling process. (auth) (UK)

18832 RADIOLYTIC OXIDATION OF PROPAN-1-OL. Basson, R. A.; van der Linde, H. J. (Atomic Energy Board, Pretoria, S. Afr.). J. Chem. Soc., A, No. 3, 662-5(1968).

The main products of the radiolytic oxidation of 1-propanol were identified as hydrogen, propionaldehyde, hydrogen peroxide, propionic acid, formaldehyde, and ethane. The yield of hydrogen was lower, and that of propionaldehyde three to four times higher, than in deaerated propanol. The yields of propionaldehyde and hydrogen peroxide were higher, and that of propionic acid lower, in air-saturated than in oxyten-saturated solution. The results indicate a short chain reaction, and a mechanism is suggested to explain the observed effects. (auth) (UK)

18833 RADIOLYSIS OF LIQUID PROPANE: RADICAL REACTIONS. Koob, R. D.; Kevan, Larry (Univ. of Kansas, Lawrence). Trans. Faraday Soc., 64: 422-9(Feb. 1968).

The radical reactions in the liquid phase γ-radiolysis of propane were studied from –130 to 35°C and compared with the gas-phase radiolysis at 35°C. Oxygen was used as a scavenger to separate thermal radical yields, and effects of phase and temperature on the radical yields were assessed. It was found that the gas-liquid phase change decreased total decomposition by about 14%; increased disproportionation/combination (D/C) ratios for all radicals by 30%; and decreased the isopropyl/n-propyl radical ratio. Decrease in liquid temperature changed the predominant reaction of H-atoms from abstraction from propane to addition to product propylene below –78°C at doses of 1 MRAD, increased the D/C ratios by 31%, and decreased the isopropyl/n-propyl radical ratio. Dose effects were briefly studied; they are complex and cannot be explained by radical reactions alone. (auth) (UK)

18834 DOSE-RATE EFFECTS IN THE RADIOLYSIS OF LIQUID N-HEXANE. Barker, R. (United Kingdom Atomic Energy Authority, Wantage, Eng.). Trans. Faraday Soc., 64: 430-9(Feb. 1968).

The radiolysis of liquid n-hexane was studied over a wide range of dose-rates (4.7×10^{17} to 1.6×10^{20} eV g^{-1} sec^{-1}) and the yields of the intermediate molecular weight products (C_i) dodecane and hexene were measured. A decrease in G(C_i) with decreasing dose-

rate, expected of free radical behavior was found, but there was a small "residual" yield of C_1 products at the lowest dose-rate studied. This yield was further reduced when iodine (5×10^{-3} M) was added to the hexane. The increase in G(dodecane) with decreasing dose-rate was less than the decrease in $G(C_1)$ due to an overall change from primary to secondary radicals (in a structural sense), the resulting radicals producing hexene rather than dodecane. Analysis of the distribution of dodecane isomers led to the relative yields of the three hexyl radicals and the variation of these with dose-rate was followed. (auth) (UK)

18835 THE POLYMERIZATION OF 1-CYCLICIMIDO-1,3-BUTADIENES AND THOSE GRAFT-COPOLYMERIZATION TO POLYETHYLENE BY GAMMA RADIATION. Murata, Kenichi (Government Industrial Research Inst., Osaka). Kogyo Kagaku Zasshi, 70: 2047-50(Nov. 1967). (In Japanese).

The polymerization of 1-phthalimido-1,3-butadiene (1-PB) and 1-succinimido-1,3-butadiene (1-SB) either in a solid state or in a solution, and their graft-copolymerization on polyethylene (Yukalon and Hizex films) by gamma radiation were investigated. In the solid-state polymerization, 1-PB and 1-SB were very difficult to polymerize, but solution polymerization was slightly easier. The graft-copolymerization of 1-PB or 1-SB to Yukalon could be very easily carried out comparing with that to Hizex. In graft-copolymerization of 1-PB to Yukalon, the rate of grafting was proportional to the 0.52th order of the dose rate in the range from 2400 to 1600 R/hr and the apparent activation energy was calculated to be 5.3 kcal/mol in the range from 25 to 70°C. By reacting phthalimido groups in the grafted film with n-propylamine, phthalamido groups were produced, but the ring-opening rate was very slow. The dyeing characteristics of these grafted films and amine-treated films were examined. The 1-PB-grafted film could be nicely dyed by dispersed dye and also the 1-SB-grafted film was well dyed by acid dyes, basic dye, and dispersed dye. Moreover, the amine-treated films showed marked dyeable characteristics to acid dye. (auth) (NSA of Japan)

18836 PERFLUOROALKANES IN IONIZING RADIATION. Askew, W. C.; Reed III, T. M.; Mailen, J. C. (Univ. of Florida, Gainesville). Radiat. Res., 33: 282-92(1968).

Products from the irradiation of ten pure perfluoroalkanes at 25°C by 50 to 150 Mrads of γ rays have been analyzed by gas-liquid chromatography. The numbers of molecules that disappeared per 100 eV absorbed were found to be: CF_4 (1.1), C_2F_6 (4.0), C_3F_8 (3.7), $n\text{-}C_4F_{10}$ (3.7), $i\text{-}C_4F_{10}$ (3.3), $n\text{-}C_5F_{12}$ (3.1), $n\text{-}C_6F_{14}$ (2.9), $2\text{-}CF_3C_5F_{11}$ (2.7), $3\text{-}CF_3C_5F_{11}$ (2.6), and $2,3\text{-}(CF_3)_2\text{-}C_5F_8$ (5.0). The preponderance of branched product molecules containing CF_3 groups indicated that C–F bonds at secondary and tertiary carbon are more susceptible to radiation damage than those at CF_3 groups. (auth)

18837 GAMMA RADIOLYSIS STUDIES OF THE CHLOROACETIC ACIDS. Baxter, J. N.; Johnston, F. J. (Univ. of Georgia, Athens). Contract AT(40-1)-2826. Radiat. Res., 33: 311-24(1968).

Selected product yields following gamma irradiation of aqueous mono-, di-, and trichloroacetic acids were studied over a wide concentration range. Chloride, carbon dioxide, carbon monoxide, and a variety of alkyl chlorides were measured from 0.2M to saturation, and for dichloroacetic acid, the pure acid. Scavenging experiments using I_2 and Br_2 were carried out to confirm the identity of and measure yields for radicals of the type $\cdot CH_2Cl$, $\cdot CHCl_2$, and $\cdot CCl_3$. By use of the above scavengers labeled with ^{131}I or ^{82}Br, acids formed from reaction of radicals $\cdot CH_2COOH$, $\cdot CHClCOOH$, and $\cdot CCl_2COOH$ were measured by silicic acid chromatography. Reactions are suggested to explain the formation of these species. (auth)

18838 RADIOLYSIS OF AROMATIC COMPOUNDS: DEUTERATED TOLUENE. Weiss, Jerome; Collins, Carol H. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-gen-16. Radiat. Res., 33: 274-81(1968). (BNL-11279).

Toluene, toluene-α-d_3, toluene-d_5, and toluene-d_8 were radiolyzed to 10 Mrads at 40°C. The hydrogen and methane produced were measured and analyzed for isotopic composition. An isotope effect of 5 to 6 was observed with deuterium substitution on both the ring and the side chain. Methane arose largely by abstraction from the side chain, while hydrogen resulted from unimolecular and bimolecular dissociation processes involving both ring and side-chain hydrogen atoms. (auth)

18839 GAS-PHASE RADIOLYSIS OF AMMONIA: EFFECT OF DENSITY AND ADDITIVES. Nishikawa, Masaru; Shinohara, Nobuyoshi (Tokyo Univ.). Radiat. Res., 33: 194-203(1968).

The effects of additives and density on the radiolysis of ammonia at room temperature were studied. Additives such as ethylene, nitrous oxide, and carbon tetrachloride affected $G(H_2)$ from ammonia at ~50 cm Hg to varying degrees. Comparison of values of $\Delta G(H_2)$ of different additives led to the following conclusions: The contribution from ionic processes to the total $G(H_2)$ is ~42%; ~95% of the neutralization produces H atoms rather than H_2. Over the density range 0.0005 to 0.0067 g/cc, $G(H_2) = 4.3$ to 4.6 and $G(N_2) = 1.4$ to 1.6 do not undergo appreciable decrease, in contrast to the observation of sharp decrease by others at higher density and at 137°C. A modification was proposed to the interpretation of such a decrease in terms of cluster formation, which can accommodate the observation of $NH_4^+ \cdot nNH_3$ clusters. (auth)

18840 MECHANISM INVOLVED IN THE RADIATIVE DESTRUCTION OF POLYTETRAFLUOROETHYLENE. Slovokhotova, N. A.; Muromtsev, V. I.; Asaturyan, R. A.; Zhidomirov, G. M.; Akhvlediani, I. G.; Sukhov, F. F.; Bruk, M. A. (Inst. of Physical and Chemical Research, Tokyo). Dokl. Akad. Nauk SSSR, 178: 138-40(Jan. 1, 1968). (In Russian).

The radicals formed when polytetrafluoroethylene (PTFE) is exposed to γ-radiation doses from 2 to 40 Mrad at temperatures of 4.2 and 77°K were investigated. Before exposure, the specimens were outgassed by heating them to 95°C under a vacuum of 10^{-3} to 10^{-4} mm of Hg. The electron paramagnetic resonance spectra indicated that when PTFE is irradiated at 77°K fluoroallyl radicals are formed at a much higher yield than other radicals. It was also found that in the fluoroallyl radicals as in the allyl radical, the C_1, C_2, C_3 carbon atoms are present in the SP_2 type hydridization form, and together with 3 fluorine atoms they lie in the same plane and the main bonds are parallel. After the specimens were irradiated at 77°K and then heated to 120°K, the signal of the fluoroallyl radicals was found to be greatly weakened disappearing completely at room temperature. Formation of these radicals may be due to internal double bonds originally present in the polymer or formed during the irradiation. Examination of the infrared spectra indicated the existence of an absorption bend that may be attributed to the $-CF=CF-$ type internal double bonds; after irradiation, the intensity of this band is enhanced. (TTT)

18841 CHEMICAL AFTER-EFFECTS DURING THE PREPARATION OF ^{239}Np BY MEANS OF NEUTRON IRRADIATION OF URANYL SALTS. Peretrukhin, V. F.; Krot, N. N.; Glazunov, M. P.; Gel'man, A. D. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 173: 609-11(Mar. 21, 1967). (In Russian).

Chemical data on ^{239}U and ^{239}Np accumulated in neutron-irradiated uranyl salts as a result of the $^{238}U(n,\gamma)^{239}U \xrightarrow{\beta} {}^{239}Np$ nuclear transformation were previously obtained. The yields of various forms of ^{239}U and ^{239}Np in uranyl salts and in organic solutions at 0°C were determined by dissolving the irradiated salts in corresponding acids with and without a carrier, chemical separation of the different oxidation states of ^{239}U and ^{239}Np, and measuring relative amounts of these isotopes by their γ activity. Separation was achieved by coprecipitation of U(IV) and Np(IV) with thorium oxalate and Np(IV) with sodium uranyl acetate, while Np(V) was separated from Np(IV) and Np(VI) by extraction with bis(2-ethylhexyl)phosphate. Tabulated results are analyzed. (R.V.J.)

18842 EFFECTS OF RADIOINDUCED DEFECTS ON THE SEIGNETTOELECTRIC PROPERTIES OF ROCHELLE SALT AND TRIGLYCINE SULFATE CRYSTALS. Peshikov, E. V.; Starodubtsev, S. V. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1750-3(Nov. 1967). (In Russian).

Data obtained on γ-radiation effects on the properties of Rochelle salt and triglycine sulfate crystals indicated three basic changes induced in seignettoelectric properties of materials studied. They are reduced dipole concentration caused by radiolysis, appearance of shifted internal field (the real or effective mechanism of the phenomenon is not yet clear), and interactions of defects with the domain structure (the walls and nuclei of domains). (R.V.J.)

18843 GAMMA AND X-RAY INFLUENCE OF THE BARKHAUSEN EFFECT IN SEIGNETTOELECTRIC CRYSTALS. Komlyakova, N. S.; Rudyak, V. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1762-4(Nov. 1967). (In Russian).

Preliminary studies on γ-radiation effects on Barkhausen effect in the triglycine sulfate and Rochelle salt crystals were described previously. An attempt was made to study a wider range of γ doses. The data obtained with γ doses from 5 kR to 1 MR confirmed the previous postulation that the number of Barkhausen jumps reduced with the higher doses while the starter field increased. Studies of x-radiation effects on the Barkhausen effect in the examined crystals showed that the number of jumps in the TGS and Rochelle salt crystals as a function of x-ray doses (from 150 R to 10 kR), also exhibited extreme characteristics. (R.V.J.)

18844 EXPERIMENTAL STUDIES OF γ-RADIATION EFFECTS ON THE ELECTRICAL AND SPECTRAL PROPERTIES OF TRIGLYCINE SULFATE. Danil'chuk, G. S.; Kremenchugskii, L. S.; Mal'nev, A. F. (Inst. of Physics, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1754-6(Nov. 1967). (In Russian).

Pyroelectric effects of triglycine sulfate (TGS) crystals, with low unipolarity, irradiated with low γ doses were investigated. Simultaneously with the studies of electrical (γ_d,ϵ) properties of γ-irradiated TGS crystals studies were made of their infrared absorption spectra. Data obtained were used for determining the changes taking place in seignettoelectrics irradiated by γ radiation. Diagrams are given of the temperature dependence of the pyroelectrical coefficients γ_d at various irradiation doses studied with 1 to 3 mm^2 and 100 μm specimens of TGS. The infrared spectra of irradiated and nonirradiated TGS and curves of the temperature dependence of the 575 cm^{-1} intensity band were constructed at 22, 34, 46, and 52°C and various γ doses. (R.V.J.)

18845 RADIATION EFFECTS ON ELECTROPHYSICAL PROPERTIES OF BARIUM TITANATE AND MATERIALS WITH ITS BASE. Solov'ev, S. P.; Kuz'min, I. I.; Kharchenko, V. A. (Inst. of Physics and Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1757-61(Nov. 1967). (In Russian).

Comparative studies were made of the effects of fast electrons, ^{60}Co γ rays, and mixed reactor irradiation on $BaTiO_3$ mono- and polycrystals. Bombardment was carried out with 0.14 to 1.14 MeV electrons. In order to avoid overheating of specimens, the irradiation flux was kept below 10^{13} electrons/cm^{-2}/sec^{-1}. Exposure doses did not exceed 10^{19} electrons/cm^{-2}. Gamma irradiation was carried out with a standard ^{60}Co source with doses up to 500 Mrad with 400 $R \cdot sec^{-1}$. The mixed (n + γ) irradiation was carried out in a WWR-C vertical reactor channel with integral fast neutron flux of 3.7×10^{15} neutrons $\cdot cm^{-2}$ and a flux of 1.7×10^{11} fast neutrons cm^{-2} sec^{-1}. Simultaneously the specimens received the γ-radiation dose up to 70Mrad with the power of 3400 $R \cdot sec^{-1}$. In all cases the temperature on the surface of specimens was from 30 to 35°C. Graphical results of the comparative studies were analyzed. (R.V.J.)

18846 RADIATION-INDUCED SOLUTION POLYMERIZATION OF BIS(β-CHLOROETHYL) VINYLPHOSPHONATE. Fujii, Shigetada; Yamakita, Hiromi; Matsuda, Tatsuo (Government Industrial Research Inst., Nagoya, Japan). Radiat. Res., 33: 238-48(1968).

The γ-ray-induced solution polymerization of bis(β-chloroethyl)vinyiphosphonate (CEVP) in several kinds of organic solvents was carried out, and the reaction mechanism was studied. Polymerization in a temperature range from 40° to −78°C is considered to be carried out by a free radical mechanism. The dependence on the dose rate (I) of the rate of solution polymerization (R_p) in both dioxane and chloroform showed that the indexes of I increase with the concentration of the monomer, but that they do not differ much from 0.5 in a wide range of concentration. The chain transfer constants for these two solvents from the monomer were smaller than that for the monomer in the bulk polymerization of CEVP, though they were much larger than the values found in solution polymerization of ordinary vinyl monomers. A kinetic equation has been derived from these results, and the reaction mechanisms were considered by applying the experimental data to the equation. The rates of solution polymerization were generally smaller than those of bulk polymerization, owing to the energy transfer reactions from the monomer to the solvents. (auth)

18847 THERMAL DECOMPOSITION OF IONIC SALTS AT THE MOMENT OF X-RAY IRRADIATION. Skorik, A. I.; Boldyrev, V. V.; Komarov, V. F. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). Kinet. Kataliz, 8: 1258-64 (Nov.-Dec. 1967). (In Russian).

The effects of x-irradiation on the thermal degradation of Ag_2O, AgN_3, K_2CrO_4, $(NH_4)_2Cr_2O_7$, NH_4ClO_4, $KMnO_4$, $Ba(MnO_4)_2$, $AgMnO_4$, Ag_2CrO_4, $Ba(N_3)_2$, $Ca(N_3)_2$, and $Sr(N_3)_2$ salts were studied. Data obtained indicated that irradiation at the moment of thermal degradation of the salts accelerated disintegradation of $KMnO_4$, $Ba(MnO_4)_2$, $AgMnO_4$, $Ca(N_3)_2$, $Sr(N_3)_2$, and $Ba(N_3)_2$ as well as NH_4ClO_4 containing 5% Ni_2O_3 impurity. The rate of degradation of Ag_2O, AgN_3, K_2CrO_4, $(NH_4)_2Cr_2O_7$, and NH_4ClO_4 without the impurity was not affected. (R.V.J.)

18848 PRODUCTION OF RADICALS IN RADIOLYSIS OF SOLID ORGANICAL SUBSTANCES. V. RADIOLYSIS OF AROMATIC ALCOHOLS. Trofimov, V. I.; Chkheidze, I. I. (Inst. of Chemical Physics, Moscow). Kinet. Kataliz, 8: 1374-6(Nov.-Dec. 1967). (In Russian).

Radiation yields of radicals (G_R) and molecular hydrogen (G_H) were determined and EPR spectra of radicals formed during the low-temperature radiolysis of three aromatic alcohols (benzyl, phenylethyl, and phenylpropyl) were studied. The data indicated that in benzyl alcohols the radicals are formed by the two adjacent molecules connected by a hydrogen bond as a result of functional group degradation. Hydrogen atoms did not participate in radical formation. Tabulated data of radiochemical yields of radicals and hydrogen at 120°K showed that the G_R value of all alcohols was larger than unity, moreover, with increased numbers of CH_2 links the G_R value diminished. The yield of G_H in all alcohols did not exceed 0.1 1/100 eV, which is about 10 to 30 times less than G_R. (R.V.J.)

18849 RADIATION-INDUCED COPOLYMERIZATION OF BIS(β-CHLOROETHYL) VINYLPHOSPHONATE. Fuji, Shigetada (Government Industrial Research Inst., Nagoya, Japan). Radiat. Res., 33: 249-62(1968).

The γ-ray-induced copolymerization of bis(β-chloroethyl) vinylphosphonate (CEVP) with styrene (St) and methyl methacrylate (MMA) was studied. The copolymerization reactions proceeded by a free radical mechanism, and the reactivity of CEVP with other monomers was not so high. The reactivity ratios for the copolymerization of CEVP with St and MMA have been measured at 30°C. The molecular weight of the resulting copolymer decreased as the content of CEVP increased. The apparent activation energies were established to be 4.2 kcal/mole for the copolymerization of CEVP with St, and 1.6 kcal/mole with MMA. The copolymerization mechanisms for CEVP with other monomers were also studied kinetically. (auth)

18850 FREE RADICAL YIELDS IN X-IRRADIATED GLYCINE PEPTIDES. Ten Bosch, J. J. (Univ., Utrecht). Int. J. Radiat. Biol., 13: 93-5(1967).

Experiments with collagen and related gelatines indicated that the molecular weight could be one of the parameters influencing the radiation-induced radical yield. An attempt was made to detect this effect by investigating a homologous series of peptides. Glycylglycine, triglycine, tetraglycine, and polyglycine were x irradiated (50 kvp, 500 rad s^{-1}) in vacuum or in an N_2-atmosphere of a few mbar at 233°K. Radical concentrations were determined in the same atmosphere at room temperature with a self-constructed electron spin resonance spectrometer. The overall error in the absolute value of the radical concentrations in the peptide samples was determined as 12%. The error in the absorbed dose was 10%. To obtain more information on the influence of crystallinity, all materials except polyglycine were irradiated in the state in which they were received from the manufacturer (clearly polycrystalline for di- and triglycine) as well as in the lyophilized state. With glycylglycine the well-known doublet electron spin resonance spectrum was obtained. When triglycine was irradiated, a poorly resolved spectrum was found which, on storage of the sample after admission of air, changed to the doublet. This change in spectrum was accompanied by a 40% decrease in radical concentration. The spectra of irradiated tetraglycine and polyglycine resembled closely the doublets found previously. (C.H.)

18851 PREPARATION OF ^{238}Pu BY THE NEUTRON IRRADIATION OF ^{235}U AND ^{237}Np. Bak, M. A.; Krivokhatskii, A. S.; Romanov, Yu. F. At. Energ. (USSR), 23: 561-4(Dec. 1967). (In Russian).

Exposure of natural uranium to a neutron flux in a reactor yields only a very small amount of ^{238}Pu because this isotope is formed by the (n,2n) reaction under the action of fast neutrons. It may be formed by the irradiation of ^{235}U and ^{237}Np through the following stages: $^{235}U(n,\gamma)^{236}U(n,\gamma)$ $^{237}U \xrightarrow{\beta}$ $^{237}Np(n,\gamma)$ $^{238}Np \xrightarrow{\beta}$ $^{238}Pu(n,\gamma)$ ^{239}Pu ...; $^{237}Np(n,\gamma)^{238}Np \xrightarrow{\beta}$ $^{238}Pu(n,\gamma)^{239}Pu$ .... In order to determine the optimum conditions for the accumulations of ^{238}Pu, calculations were carried out on the basis of neutron fluxes of 10^{13}, 10^{14}, 10^{15}, and 10^{16} n/cm^2/sec, using previously published half-life and interaction cross section values. An equation was derived, indicating the buildup of the daughter isotopes as a function of the nuclear properties of the precursors. The results showed that the accumulated ^{238}Pu amounts to 0.2% of the initial ^{235}U upon complete burnup of the latter. If the flux is increased, the ^{238}Pu yield for the optimum irradiation period is decreased because of the burnup of the intermediate ^{239}Np nucleus. In order to obtain pure ^{238}Pu, 100% enriched ^{235}U must be used. (TTT)

18852 POLAROGRAPHY OF QUINONE DERIVATIVES IN DMF. IV. POLAROGRAPHIC STUDY OF REDUCTION OF ANTHRAQUINONE DERIVATIVES BY ^{60}Co γ-IRRADIATION. Yasukouchi, Kazuo; Ono, Yukio (Univ. of Kumamoto, Japan). Nippon Kagaku Zasshi, 88: 1276-81(Dec. 1967). (In Japanese).

The effect of substituents on the radioinduced reduction of quinone derivatives is reported. The substituent constants and the reaction constants were determined. These results showed

that, the reaction constants of anthraquinone derivatives could be determined from the relation between the half-wave potentials and substituent constants. The reaction constant was $\rho = 1.125$ in both the first and the second steps. The substituent constants of α-substituted compounds were not determined by the Hammett's constant (σ-substituent effect), but the substituent constant was determined by the rate constant. It was difficult to determine the substituent constants of compounds having substituents at β-position(m, p-substituent effect) by the rate constant. But σ_0 may be calculated by means of Yukawa–Tsuno's extended Hammett's equation, $\sigma_p^0 = \sigma_1 + \gamma\sigma_\pi$ and $\sigma_m^0 = \gamma\sigma_1 + \gamma'\sigma_\pi$. The effect of substituent groups on the mechanism of hydrogenation was recognized. 1-Nitroanthraquinone and anthraquinone-2-carboxylic acid were hydrogenated even in the state of anion–radical, but the other compounds were hydrogenated only in the state of di-anion. (auth)

18853 RADIATION POLYMERIZATION OF N-ALLYLMONOAMIDE OF MALEIC ACID IN SOLID STATE. Shcherbina, F. F.; Fedorova, I. P. (Kiev State Univ.). Vysokomol. Soedin., Ser. A, 10: 52-5(Jan. 1968). (In Russian).

N-allylmonoamides of maleic and succinic acids were polymerized in the solid state with ^{60}Co γ rays; the latter polymerized at a higher rate. In polymerization of N-allylmonoamide of maleic acid post-effect and long-living radicals were observed. (auth)

18854 DETECTION OF OXYGEN ATOMS DURING GAMMA RADIOLYSIS OF CARBON MONOXIDE GAS. Briggs, J. P.; Clay, P. G. (Imperial Coll. of Science and Tech., London). Nature (London), 217: 947(Mar. 9, 1968).

It has been suggested that CO_2 formed during the radiolysis of CO results from the reaction of O–atoms with CO. The principal evidence in support of this is the observation that during proton irradiation G_{CO_2} decreased from 2 to 0.5 mol/100 eV as the dose rate increased from 5×10^{15} to 10×10^{18} eV/ml/sec. Chemical evidence for the formation of O–atoms, together with an estimate of the yield in irradiated CO, using propene as O–atom scavenger is described. A 17,000-Ci ^{60}Co source was employed for the irradiations, at a dose rate of $\sim 3 \times 10^{13}$ eV/ml/sec, together with ferrous sulphate dosimetry. The reaction products were identified and quantitatively estimated using a gas chromatograph with a flame ionization detector. Irradiation was found to result in the formation of products characteristic of the reaction of $O(^3p)$ atoms with propene; the G-values are tabulated and discussed. The mechanism of formation of the O–atoms, and the electronic state in which they are initially formed, are uncertain. (UK)

18855 PRODUCTION OF ARTIFICIAL RADIOACTIVE PARTICLES. Rajewsky, B.; Nay, U.; Schmidt-Burbach, G.; Friedrich, E. (Max Planck-Institut fuer Biophysik, Frankfurt am Main). Biophysik, 4: 183-6(1967). (In German).

Artificial radioactive particles were prepared in the form of large plexiglass pearls 5 to 20 μm in diameter. An organic scandium compound was homogeneously deposited in the plexiglass. After neutron activation of the pearls in the reactor, ^{46}Sc with an activity up to 10^{-10} Ci was obtained in a particle on 10 μm diameter. (tr-auth)

18856 RADIATSIONNAYA POLIMERIZATSIYA. (Radiation Polymerization). Ivanov, V. S. Leningrad, Izdatel'stvo Khimiya, 1967. 232p.

The radiation chemistry of polymerization and a new method for polymer synthesis by ionizing radiation are discussed. The principal basis of polymerization methods are discussed in the first chapter. Radiation polymerization advantages and disadvantages are analyzed and descriptions are given of the devices used for radiative treatments of monomers, and of various factors contributing to the radiation polymerization processes. Mechanism of radiation copolymerization, the singularities of the solid phase, and channel polymerization are also discussed in the first chapter. The second chapter includes the practical applications of radiation polymerization method in order to obtain polymers from ~350 monomers. Extensive references for each chapter are included. (R.V.J.)

18857 KHIMIYA I TEKHNOLOGIYA SINTETICHESKIKH VYSOKOMOLEKULYARNYKH SOEDINENII. KARBOTSEPNYE POLIMERY. (Chemistry and Technology of Synthetic High-Molecular-Weight Compounds. Carbon-Chain Polymers. Korshak, V. V. Itogi Nauki. Khimicheskie Nauki, 9. Moscow, Izdatel'stvo Nauka, 1967. 943p.

An extensive review is given on the chemistry and technology of synthetic polymers. The review is dedicated to carbon-chain polymers. Theoretical problems of polymerization are discussed. Polymerization of saturated hydrocarbon polymers (polyethylene, polypropylene, polybutylene, polystyrene, and butyl rubber) is covered. Polymethyl halogen derivatives including radioinduced polymerization of vinylchlorides, emulsion polymerization, and properties of polyvinyl chloride and vinylchloride copolymers are considered. Oxygen polymethyl derivatives and polymethylene derivatives containing nitrogen, silicon, phosphorus, and sulfur are discussed. Unsaturated hydrocarbon polymers and their derivatives (polybutadiene, polyisoprene, isoprene rubber, and polychloroprene), rubber technology, production and reprocessing, and cyclic carbon-chain high-molecular compounds are included. Extensive bibliographies and patent data are included. (R.V.J.)

18858 ACTIUNEA RADIATILOR IONIZANTE ASUPRA APEI SI SOLUTIILOR APOASE. (Action of Ionizing Radiation on Water and Aqueous Solutions). Fiti, Maria Bucharest, Editura Academiei Republicii Socialiste, Romania, 1967. 267p.

A general review of the theoretical and experimental material in the field of chemical processes induced by ionizing radiations in water and aqueous solutions is presented. Special attention is devoted to the reactions of hydrated electrons as a radiolytic species. Topics treated are the general problems of radiation chemistry, the primary processes involved in the radiolysis of water, radiolysis of aqueous solutions, the influence of various parameters in aqueous radiolytic processes, pulsed radiolysis, and the radiolysis of some aqueous solutions of organic compounds. Five hundred eighty-three references are included. (TTT)

Radiochemistry

Refer also to abstracts 18737, 18811, and 20975.

18859 LIMITS FOR QUALITATIVE DETECTION AND QUANTITATIVE DETERMINATION. APPLICATION TO RADIOCHEMISTRY. Currie, Lloyd A. (National Bureau of Standards, Washington, D. C.). Anal. Chem., 40: 586-93 (Mar. 1968).

A re-examination of the questions of signal detection and signal extraction in analytical chemistry and nuclear chemistry was made. Three limiting levels were defined: L_C–the net signal level (instrument response) above which an observed signal may be reliably recognized as "detected"; L_D–the "true" net signal level, which may be a priori expected to lead to detection; and L_Q–the level at which the measurement precision will be satisfactory for quantitative determination. Exact defining equations as well as series of working formulae are presented both for the general analytical case and for radioactivity. The latter, assumed to be governed by the Poisson distribution, is treated in such a manner that accurate limits may be derived for both short- and long-lived radionuclides either in the presence or absence of interference. The principles are illustrated by simple examples of spectrophotometry and radioactivity, and by a more complicated example of activation analysis in which a choice must be made between alternative nuclear reactions. (auth)

18860 INCORPORATION OF RADIOACTIVE AMINO-ACIDS IN THE α AND β POLYPEPTIDE CHAINS OF HEMOGLOBIN IN SYSTEMS OF VARYING COMPLEXITY. Kristman, M. G.; Surnin, Yu. N.; Konikova, A. S. (Inst. of Therapy, Moscow. Inst. of Surgery, Moscow). Dokl. Akad, Nauk SSSR, 176: 212-15(Sept. 1, 1967). (In Russian).

In view of the physiological importance of hemoglobin, this material was used to study the incorporation of free, radioactive amino acids into the α and β polypeptide chains of hemoglobin in the whole body making also in vitro tests with isolated reticulocytes and hemoglobin. ^{14}C-phenylalanine and ^{14}C-lysine were injected intraperitoneally into rabbits with at least 70% reticulocytes, at a rate of 0.5 to 1 mCi per kg of body weight. The result indicated that the phenylalanine was most intensively incorporated in the "hemoglobin-amino acid" system, while the ^{14}C-lysine was incorporated at the fastest rate in the "reticulocyte-amino acid" system. The times needed to incorporate the phenylalanine in vivo and into the isolated reticulocytes were identical. Thus periods of passage of the free amino acids of the two compounds into the globin molecule in the whole body and in vitro differ as shown by the fact that the specific activities per 1 μmole of the α and β chains are not proportional involved amino acid residues. (TTT)

Separation Processes

Refer also to abstracts 18710, 18720, 18725, 18737, 18750, 18795, 18811, 18980–18992, 19016–19018, 19475, and 20558.

18861 (BNWL–584) DIBUTYL CARBITOL SOLVENT EXTRACTION OF ^{210}Po FROM NITRIC ACID SOLUTIONS OF IRRADIATED BISMUTH. Schulz, W. W.; Richardson, G. L.

(Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1968. Contract AT(45-1)-1830. 58p. Dep. CFSTI.

A continuous countercurrent solvent extraction process utilizing dibutyl carbitol as the extractant was developed for separating ^{210}Po from large amounts of associated bismuth. Both laboratory and pilot plant data demonstrate the process is a suitable head-end step in recovery of kilogram quantities of ^{210}Po. Typically, the extraction process recovers over 98% of the ^{210}Po, essentially free from bismuth (Bi DF > 1500), in a dilute HNO_3 solution suitable as a starting material for final concentration and purification steps. (auth)

18862 (DOCKET-50201-2) SPENT FUEL PROCESSING PLANT. [Preliminary Safety Analysis Report], Part B, Vol. 1. (Nuclear Fuel Services, Inc., [West Valley, N. Y.]). July 26, 1962. 501p. Dep. CFSTI.

A description and safety analysis of the Spent Fuel Processing Plant, that Nuclear Fuel Services, Inc., wants to build on the Western New York Nuclear Service Center near Riceville, New York, are presented. The site, plant, process, and equipment are described. The plant is capable of processing any type of fuel element from which the fuel proper can be reduced to a nitric acid solution. Protection of the public and of plant personnel is discussed. (M.C.G.)

18863 (DOCKET-50201-3) SPENT FUEL PROCESSING PLANT. [Preliminary Safety Analysis Report], Part B, Vol. 2. (Nuclear Fuel Services, Inc., [West Valley, N. Y.]). July 26, 1962. 250p. Dep. CFSTI.

An engineering analysis of the Spent Fuel Processing Plant that Nuclear Fuel Services, Inc., wants to build is presented. Ventilation, sampling and analysis, maintenance, shielding, monitoring, utilities, and criticality are discussed. (M.C.G.)

18864 (NP-17286) ETUDE DE LA SEPARATION CHROMATOGRAPHIQUE DE TERRES RARES. (Study of the Chromatographic Separation of Rare Earths). Godart, Jacques (Grenoble Univ. (France). Faculte des Sciences). [Mar. 18, 1966]. 44p. (In French). Dep.

Thesis.

The effect of experimental conditions on the separation of two neighboring rare earths by means of ion exchange resins was analyzed. The principle of chromatographic separation is outlined. The separation of Yb and Lu was studied experimentally. The experimental apparatus used, the processing of the resin, the preparation of the column, and the fixation and elution of the rare earths are described. The degree of separation of the two elements at various molarities, the measurement of the partition coefficients, and the estimation of the nature of the predominant complex in the solution were determined. The methods used for the preparation of a ^{174}Lu source are described. The effect of a pH gradient on the separation of the rare earths was investigated. The results showed that it is possible to separate Yb and Lu with an excellent degree of purity. The K_d curves as a function of pH at various molarities made it possible to predict that at concentrations below 0.1 M the variation of K_d becomes weaker and weaker. The separation of Gd and Tb was then studied. (J.S.R.)

18865 (ORNL-4212) SOLVENT STABILITY IN NUCLEAR FUEL PROCESSING: EVALUATION OF THE LITERATURE, CALCULATION OF RADIATION DOSE, AND EFFECTS OF IODINE AND PLUTONIUM. Blake, Charles A. Jr. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 35p. Dep. CFSTI.

A survey of the literature was made to accumulate information concerning the stability of organic solvents during the processing of nuclear fuels. Many of the data, obtained in laboratory studies of solvent stability against radiation and chemical attack, require large extrapolations when they are used to predict results during actual fuel processing operations. In these laboratory studies, radiation exposures were frequently massive, that is, up to 100 Wh/liter compared with those expected (0.05 to 1.0 Wh each cycle) during fast-reactor fuel processing. It was concluded that: extrapolation of most of the reported data to predict process conditions would produce erroneous results; the decrease in decontamination factors for fission products in the tributyl phosphate–hydrocarbon–heavy metal systems will probably not be significant (perhaps up to a factor of 2) at a solvent radiation exposure of 0.5 Wh per liter per cycle; and adequate solvent wash systems will limit the cumulative effect of radiation. Good solvent performance was observed in installations that employ continuous processing methods; here, accumulated doses have exceeded tens of watt-hours per liter. Solvent exposure in pulsed columns is a function of processing conditions such as heavy metal and tributyl phosphate (TBP) concentrations, extent of flooding, and contact time. For example, with 15% TBP in dodecane and a flow rate that is 75% of flooding, the calculated solvent exposure would be less than 0.1 whr per liter per cycle when 30-day-cooled fast reactor fuel having an average burnup of 38,500 Mwd/metric ton is processed. The solvent exposures would be higher in present mixer-settler contactors and lower in contactors having short residence times. The alpha radiation from plutonium does not contribute significantly to solvent exposure in the first cycle of extraction with thermal reactor fuels but can contribute approximately 10% of the total dose for fast-reactor fuels, in which 1% of the plutonium is present as ^{238}Pu. Alpha radiation effects in the second plutonium cycle are more significant and are proportional to the plutonium concentration and the residence time of plutonium in the organic phase. A standard method is proposed for calculation of solvent exposure. Assuming that homogeneous phase mixing is a basic parameter, solvent exposure in the mixing chambers is found to be equal to the product of the radiation density of the aqueous feed (w/liter), the volume fraction of the aqueous feed in the mixing chamber, and the residence time of the organic phase in the mixing chamber (hr). The calculation of additional exposure that is incurred in the settling chambers in various contactors requires special assumptions for each contactor. Sufficient data are not found in the literature to allow a quantitative prediction of the distribution of iodine between the dissolver, the off-gas, and solvent extraction system under varying conditions. (auth)

18866 (ORNL-4213) HOT-CELL EVALUATION OF THE GRIND-LEACH PROCESS. II. RECOVERY OF URANIUM AND THORIUM FROM IRRADIATED PYROLYTIC-CARBON-COATED SOL-GEL THORIA-URANIA PARTICLES. Goode, J. H.; Flanary, J. R. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 17p. Dep. CFSTI.

Duplex-coated sol-gel ThO_2 and $(Th,U)O_2$ particles irradiated to burnups of 15,000 and 17,000 Mwd/ton (Th + U) and allowed to decay for 10 to 19 months were ground to −100 mesh to ensure fracture of the kernels and the pyrolytic-carbon coatings, and then leached in boiling fluoride-catalyzed nitric acid to dissolve the thorium, uranium, and fission products. Recoveries of at least 99.6% of the uranium and 99.9% of the thorium were realized, and more than 86% of the gamma emitters were dissolved. These results contrast markedly with the uranium and thorium recoveries, as low as 95.4 and 93.1%, respectively, obtained in earlier grind-leach studies with laminar-coated $(Th,U)C_2$ particles in a graphite matrix. The grind-leach process may, therefore, be applicable to HTGR fuels containing coated sol-gel oxide particles. However, the process may be of marginal value since the leached residue must be stored as high-level radioactive waste. (auth)

18867 (RFP-890) EFFECTS OF ACID CONCENTRATION AND FEED-PARTICLE SIZE ON THE DISSOLUTION OF PLUTONIUM-BEARING MATERIALS. Molen, G. F. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Feb. 29, 1968. Contract AT(29-1)-1106. 10p. Dep. CFSTI.

The dissolution of plutonium-bearing residues in a nitric acid–calcium fluoride solvent system is described. The acid concentration, mesh size, initial solid-to-liquid ratio and initial feed material concentration are evaluated in terms of the effects they have on the dissolution of these residues. The reproducibility of ash dissolution results is also measured. (auth)

18868 (RISO-166) URANIUM FROM LEACHING LIQUORS BY PRECIPITATION. Soerensen, Emil; Lundgaard, T. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct. 1967. 13p. Dep.

An attempt was made to adapt the uranous phosphate method for uranium recovery by precipitation from sblutions rich in sulfate. Observations made during this work led to a convenient preparation of sodium uranous sulfite and sodium basic uranous sulfate. It was shown that under certain conditions these compounds cause a nearly complete precipitation of the uranium and yield better concentrates than the phosphate method. (auth) (Denmark)

18869 (STI/PUB-146) PROCESSING OF LOW-GRADE URANIUM ORES. Panel Proceeding Series. Proceedings of a Panel Held in Vienna, June 27–July 1, 1966. (International Atomic Energy Agency, Vienna (Austria)). June 1967. 247p. IAEA: $5.00; Austrian Schillings 130,-; £1.15.4; F Fr. 24.50; DM 20,-.

Twenty-six papers on the processing of low-grade uranium ores are presented. A separate abstract was prepared for each. (L.C.L.)

For abstracts of individual papers see: 18889–18901 and 18980–18992.

18870 (MLM-1483(tr)) SEPARATION OF ^{36}Ar BY THERMAL DIFFUSION. Casas, J.; Quintanilla, M.; Saviron, J. M.; Madariaga, J. A. Translated for Mound Lab., Miamisburg,

Ohio, from An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 91-8(1967). 16p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 28066. (J.G.B.)

18871 (MLM-1484(tr)) DIFFUSION PROCESSES IN CLUSIUS-DICKEL COLUMNS. Saviron, J. M.; Madariaga, J. A.; Quintanilla, M. Translated for Mound Lab., Miamisburg, Ohio, from An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 79-82(1967). 12p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 28064. (J.G.B.)

18872 (NSJ-tr-91) SOME ASPECTS OF FIXATION OF URANIUM FROM NATURAL WATERS. Muto, Tadashi; Hirono, Shuichiro; Kurata, Hideo. Translated from Kozan Chishitsu, 15: No. 74, 287-98(Dec. 1965). 30p. Dep. JCL $2.60 fs, $1.10 mf.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 25202. (J.G.B.)

18873 (ORNL-tr-1901) STABILITY OF HNO_3-TBP DILUENT SYSTEMS: BIBLIOGRAPHY OF DATA UP TO JUNE 1966. Salomon, L.; Lopez-Menchero, E. [(European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium))]. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from report ETR-203. 50p. Dep. CFSTI. JCL $4.60 fs, $1.70 mf.

Bibliographic data concerning the stability of TBP and its solutions and both their chemical and radiolytic degradation are presented. The problems of pre-treatment, regeneration, and decontamination of the solvents were also analyzed. (48 references) (auth)

18874 COPRECIPITATION OF STRONTIUM WITH Pb(II) SULFATE FROM RADIOACTIVE WASTES. LABORATORY STUDIES. Sistkova, Nina; Kolarik, Zdenek (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ., 14: 93-7(Mar. 1968). (In Czech).

Coprecipitation of strontium with Pb(II) sulfate from simulated Purex wastes (SPW) was studied. The influence of the following factors was examined: the rate of lead ion addition; duration of stirring after precipitation; order of addition of the precipitating agents; temperature of the mixture at the respective stages; and total concentration of the precipitation agents and of some components of SPW. Coprecipitation of other fission products was also investigated. Conditions of the precipitation operation were proposed under which it is possible to recover more than 95% of the strontium by threefold coprecipitation. The principal possibility of the repeated use of lead from the second and the third coprecipitation was shown. Sorption of strontium on previously prepared precipitates of Pb(II) sulfate was elucidated. (auth)

18875 SOLIDIFICATION OF HIGH-LEVEL RADIOACTIVE WASTES. PART 5. THE HEAT EVOLUTION AND TEMPERATURE DISTRIBUTION IN BASALT CONTAINING HIGH-LEVEL RADIOACTIVE WASTES. Ralkova, J.; Saidl, J. (Institut fuer Kernforschung, Rez, Czech.). Kernenergie, 10: 372-5(Dec. 1967). (In German).

Temperature increases in melted basalt caused by the decay heat from incorporated radionuclides were calculated. Besides practical cases upper limits of amounts that could be incorporated into a definite geometric body without effecting the solid state of basalt were determined. The influence of the ballast admixtures and of incorporated radionuclides on the structural changes was taken into account. (auth)

18876 SOME REGULARITIES IN THE EXTRACTION OF RARE EARTH ELEMENTS AND YTTRIUM WITH TRIALKYLPHOSPHINE OXIDE. Popkov, I. N.; Tselik, I. N.; Chernega, L. P.; Pentkovskaya, T. A.; Burova, T. I.; Laskorin, B. N. (Inst. of General and Inorganic Chemistry, Odessa). Dokl. Akad. Nauk SSSR, 173: 1351-2(Apr. 21, 1967). (In Russian).

The basic principles of the extraction of lanthanum, praseodymium, samarium, and yttrium with trialkylphosphine oxide (TAPO) from nitric acid solutions were studied. The experimental data showed that the distribution coefficients D of the rare earths and yttrium were a function of their concentration in the raffinate; $D = A \cdot C^{-n}$, where A is a coefficient dependent on the concentration of the extracting agent, nature of the diluent, and solution composition; C is the equilibrium concentration of the metal in the solution, and n is a constant for a given acidity of the solution. Coefficients D of the rare earths and yttrium decreased with increasing HNO_3 concentration in the solution, whereas the opposite is true in extraction with tributyl phosphate (TBP). D changed in proportion to the concentration of the extractant in the organic solvent. These relations are adequately described by the equation of the straight line $\log D = q \log [TAPO] + b$, where b is a constant and q is the number of TAPO molecules entering into the composition of the complex being extracted. The basic equation of the extraction equilibrium is $Zn^{2+}_{(aq)} + 3NO^-_{3(aq)} + TAPO_{(o)} \rightleftharpoons [Zn(NO_3)_2 \cdot TAPO]_{(o)}$. The mechanisms of extraction of rare earth elements with phosphates and phosphine oxides are similar, but from TBP to TAPO the solvate number changes from 3 to 1. (ATD)

18877 SEPARATION OF AMERICIUM FROM CURIUM BY PRECIPITATION OF $K_3AmO_2(CO_3)_3$. Burney, Glenn A. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Appl., 4: 217-21(Apr. 1968).

A chemical process was developed for the separation of ^{243}Am from ^{244}Cm for use in the production of kilogram quantities of ^{244}Cm. In the process, americium is oxidized to the AmO_2^+ ion in concentrated K_2CO_3 solution, and $K_3AmO_2(CO_3)_2$ is precipitated; Cm(III) is not oxidized and remains as a soluble complex in the carbonate solution. A study of the variables affecting the separation is reported. (auth)

18878 SEPARATION ^{60}Co FROM RADIOACTIVE SOLUTION BY ION EXCHANGE. Lambrino, Vl.; Furnica, Gh. Rev. Chim. (Bucharest), 18: 491-3(Aug. 1967). (In Rumanian).

Various montmorillonite-type bentonites were examined for application as an exchange agent for separation of ^{60}Co from solutions. In order to increase the mechanical strength and the ion-exchange capacity of the grains, the material was heat-treated at 200, 400, and 700°C for 2 hours. The decontaminating efficiency was determined by measuring the activity changes of a ^{60}Co solution after dynamic filtration through a 300-mm high, 12-mm high diameter column for periods of 10, 13, 17, and 20 minutes, and after static contact treatment for 15, 30, 45, and 60 minutes and 24, 48, and 72 hours, varying the amount of bentonite. The dynamic method indicated efficiencies of 99.8 and 97.8%. In the case of the contact method, the decontaminating efficiency was proportional with the time of contact; it was also affected by the amount of material used. Under optimum conditions, the results lay between 99 and 99.8%. (TTT)

18879 RECOVERY OF U_3O_8 BY UNDERGROUND LEACHING. MacGregor, Robert A. (Stahrock Uranium Mines Ltd., Elliot Lake, Ont.). Trans. Can. Inst. Mining Met., 69: 162-6(1966).

A combination of fast high-pressure washing and rewashing of stops on a predetermined cycle, and the intermittent sprinkling of low-grade heaps, using both fresh water and recirculated acid water, was used successfully for leaching mined-out areas. There was also a correlation of daily sampling data points to a relation between the leach water grade and the grade of the material being washed, the leaching time and the location along the dip. An increasing tolerance for uranium by the acid-producing bacteria was also indicated. A steady production rate of 10,000 to 12,000 lbs of U_3O_8 per month is being maintained, with an over-all mine water grade of 0.25 lb per ton and a pH of 2.3. (auth)

18880 SCHEME FOR THE QUALITATIVE ANALYSIS OF LESS COMMON CATIONS USING THE RING-OVEN METHOD. Ghose, Animesh K.; Dey, Arun K. (Univ. of Allahabad, India). Separ. Sci., 2: 673-9(Nov. 1967).

The schematic separation of 14 less familiar cations, viz., gold, beryllium, thallium, cerium, titanium, zirconium, thorium, vanadium, molybdenum, tungsten, uranium, selenium tellurium, and platinum, from mixtures was worked out by using the ring-oven method. The cations after separation were identified by spot reagents. (auth)

18881 SEPARATION OF ALKALI-METAL IONS FROM EACH OTHER AND FROM OTHER METAL IONS ON ION-EXCHANGE PAPERS. Sherma, Joseph; Goldstein, David A.; Gutai, James P. (Lafayette Coll., Easton, Pa.). Separ. Sci., 2: 691-5(Nov. 1967).

Cation-exchange paper chromatography with mixed solvents provided for the mutual separation of the alkali-metal ions. Development with a complexing solution on anion-exchange paper provided for the separation of the alkali metals as a group from other monovalent and multivalent metal ions. (auth)

18882 SEPARATION OF THE RARE EARTHS BY ANION EXCHANGE IN WATER-SOLVENT MIXTURES IN THE PRESENCE OF LACTIC ACID. Faris, John P. (Argonne National Lab., Ill.). J. Chromatogr., 32: 795-7(Feb. 20, 1968).

Adsorption characteristics of the rare earths in various water-solvent mixtures containing lactic acid as the complexing agent are presented. Adsorption of the lanthanides from lactic acid solutions was greater than that obtained using α-hydroxybutyric acid, but with less separation between adjacent members of series. Separation factors averaged about 1.5 for Ce-La and then graduated from 1.3 for Pr-Ce to 1.2 for Lu-Yb, except that Gd was separated less from Eu than from Tb. Distribution coefficients generally in-

creased with lactic acid concentration but separation factors between all elements except La were not appreciably affected. A comparison of rare earth adsorption in nine solvents containing a constant proportion of water and lactic acid is given. Separation of adjacent rare earths was somewhat in methanol than in any solvent tested. Sr and Ba were not absorbed and could readily be separated from rare earths. Ferric ion was strongly absorbed from aqueous solutions of lactic acid. It was concluded that anion exchange in mixed solvents containing lactic acid offers a simple means of separating the rare earth group from the alkaline earth group. (D.H.M.)

18883 SOLVENT EXTRACTION OF TRANSURANIUM ELEMENTS. Agee, J. E.; Roth, J. A. (Vanderbilt Univ., Nashville). Separ. Sci., 2: 563-73(Nov. 1967).

Steady-state and unsteady-state digital computer programs, processed on an IBM 7072 computer, were used to obtain the concentration profiles for hydrochloric acid, curium, americium, and europium for a 16-stage liquid–liquid extraction process that is the final purification step in the production of ^{244}Cm. The equilibrium data were in the form of empirical equations that were suitable for the computer solutions. The steady-state program, a trial-and-error procedure based on a mass balance and an equilibrium and efficiency condition written for each stage, was used to investigate the effect of changing the system variables on the separation. The unsteady-state program, based on mass balances and an equilibrium condition for each stage, was used to obtain the unsteady-state buildup of the transuranium concentration profiles for a step change in the transuranium feed concentrations. (auth)

18884 APPLICATION OF SOLVENT EXTRACTION TO THE REFINING OF PRECIOUS METALS. II. PURIFICATION OF RUTHENIUM. Khan, M. Ali; Morris, D. F. C. (Brunel Univ., London). Separ. Sci., 2: 635-44(Nov. 1967).

A procedure for the purification of ruthenium based on its extraction as the tetroxide by carbon tetrachloride is described. Radiotracer studies showed that the method provides an excellent quantitative separation of ruthenium from several other elements. It appears that advantages could ensue from the incorporation of a scaled-up version of the procedure in the process for the commercial refining of ruthenium. (auth)

18885 SEPARATION OF CARRIER-FREE As(III) FROM As(V) BY THE THIN-LAYER CHROMATOGRAPHIC METHOD. Ikeda, Nagao; Sukawa, Tadaaki; Oguma, Koichi (Tokyo Kyoiku Univ.). Radioisotopes (Tokyo), 17: 68-70(Feb. 1968).

The simple and rapid separation of recoiling arsenite-^{76}As, which is produced by the neutron irradiation of arsenates, from the target was investigated by thin-layer chromatography. The thin-layer plate was prepared by spreading "Wakogel B-5" silicagel containing 5% gypsum on a glass plate in 250 μ thickness. Several developers were tested. By developing with acetone + concentrated H_3PO_4 (10:1), As(III) with or without the carrier can be readily separated from As(V) in the developing time of 20 to 30 min. (auth)

18886 STUDIES ON THE DISTRIBUTION OF IODIDE COMPLEXES BETWEEN MINERAL ACID SOLUTIONS AND LONG-CHAIN SECONDARY AMINES (AMBERITE LA-2). Markl, P.; Markl, Ilse; Hecht, F. (Univ., Vienna). Mikrochim. Acta, No. 1, 1-12(1968). (In German).

A study was made of the distribution of a series of iodide complexes between mineral acid solutions of various molarity, which were 0.1M with respect to KI, and a 2% solution in xylene of the mixture of long chain secondary amines known as Amberlite LA-2. A number of separations of various elements is suggested on the basis of the partition coefficients obtained. (auth)

18887 SEPARATION OF THE ALKALI GROUP BY THIN-LAYER CHROMATOGRAPHY USING A BINARY SOLVENT MIXTURE. Janauer, Gilbert E.; Carrano, John D.; Johnston, Robert C. (State Univ. of New York, Binghamton). Mikrochim. Acta, No. 1, 61-5(1968).

The use of a binary solvent mixture (nitromethane/benzene) was found to result in an improved separation of the polyiodides of the entire alkali group on thin-layers of air-moist silica gel. (auth)

18888 INTENSIFICATION OF THE ION EXCHANGE METHOD FOR THE SEPARATION OF LANTHANIDES WITH THE HELP OF HEDTA. Hubicki, Wlodzimierz; Wojcik, Maira. Ann. Univ. Mariae Curie-Sklodowska, Lublin-Pol., Sect. AA, 20: 87-91 (1965). (In German).

With ratios of the yield of ion-exchange columns saturated with lanthanides and of columns for the development of chromatograms using HEDTA (hydroxyethylethylenediaminetriacetic acid) equal to 1:2 and 1:1.5, good separations were obtained for the following pairs: La–Pr, Pr–Nd, and Nd–(Y)–Sm. By the use of 5 columns, 2 of which were saturated with the rare earths, lanthanum was eluted from the third column, Pr from the fourth, and Nd, Y, and Sm from the fifth. (tr-auth)

18889 URANIUM PROCESSING RESEARCH IN AUSTRALIA. Stewart, J. R. (Australian Atomic Energy Commission, Coogee). pp 67-78 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967.

See STI/PUB-146.

Uranium processing research in Australia has included studies of flotation, magnetic separation, gravity separation, heavy medium separation, atmospheric leaching, multistage leaching, alkali leaching, solar heating of leach pulps, jigged-bed resin-in-pulp and solvent-in-pulp extraction. Brief details of the results obtained are given. Gravity, magnetic, and flotation methods are considered of limited usefulness in the treatment of Australian uranium ores. Alkali leaching seldom gives satifactory recoveries and multistage leaching is expensive. Jigged-bed-resin-in-pulp and packed tower solvent-in-pulp extraction systems both show promise, but plant-scale development work is required. Bacterial leaching may be useful in the case of certain low grade ores. The main difficulties to be overcome, either singly or in combination, in the case of Australian uranium ores not currently considered exploitable, are the extremely finely divided state of the uranium mineral, the refractory nature of the uranium mineral, and adverse effects due to the gangue minerals present. With respect to known low-grade ores, it would be possible in only a few cases to achieve satisfactory recovery of uranium at reasonable cost by standard treatment methods. (auth)

18890 RECENT DEVELOPMENTS IN THE TREATMENT OF URANIUM ORES FROM THE ELLIOT LAKE DISTRICT. Downes K. W. (Dept. of Mines and Technical Surveys, Ottawa). pp 79-88 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967.

See STI/PUB-146.

A summary of the results obtained during investigations on the treatment of uranium ores from the Elliot Lake district in the laboratories of the Mines Branch, and of developments in operating procedures introduced in the uranium mills in the Elliot Lake district, is presented. Concentration of Elliot Lake ore on a pilot-plant scale by a combined gravity-flotation procedure yielded a 90% recovery of uranium at a ratio of concentration of 2.4 to 1.0. The mineralogic composition of the ore, the flow sheet used, and the reagents employed are described. An approximate cost estimate indicates that, although the capacity of an existing uranium leaching plant would be doubled by introducing the procedure, the production cost per pound of U_3O_8 would not be affected. Bacterial leaching of Elliot Lake ore on a laboratory scale yielded under favorable conditions, extractions of 90% in 5 weeks, and of 95% in 15 weeks. The conditions that were found to influence the leaching results are outlined, and the effects of the leaching solutions are discussed. The purification of ion-exchange eluates by liquid-liquid extraction, using tri-n-butyl phosphate, dibutyl butylphosphate, and tri-capryl amine in a continuous process, yielded solutions from which refined ammonium diuranate was precipitated using gaseous ammonia. The effectiveness of the three extractants is discussed, and the effects of the procedures employed on the production costs per pound of U_3O_8 is estimated. Some improvements in operating procedures introduced in the Elliot Lake district uranium mills are briefly described, and their effects on the operations are indicated. Present methods of controlling radiological pollution of drainage waters by uranium mill tailings are outlined. (auth)

18891 PROCESSING URANIUM-BEARING MATERIALS CONTAINING COAL AND LOAM. Civin, V.; Prochazka, J. (Research and Development Lab. No. 3 of the Uranium Industry, Prague). pp 89-95 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967.

See STI/PUB-146.

Among the ores classified as low grade are mixtures of coal and bentonitic loam of tertiary origin, containing approximately 0.1% U and with a moisture content at times well above 20 to 30%. The uranium is held mainly by the carbonaceous component. Conventional processing of these materials presents various difficulties that are not easily overcome. During leaching the pulp thickens and frequently becomes pasty, due to the presence of montmorillonites. Further complications arise from the high sorption capacity of the materials (again primarily due to montmorillonites) and poor sedimentation of the viscous pulps. In addition, the materials are highly refractory to the leaching agents. The following basic routes of processing these ores were explored: separation of the carbonaceous and loamy components; "liquifying" the pulps or preventing the thickening of the pulp by addition of suitable agents; joint acid or carbonate processing of the materials in question with

current ore types; removal or suppression of thixotropic behavior by thermal pretreatment of the material; and application of the "acid cure" method. The first method appears to be the most effective, but it presents considerable difficulties due to the extreme dispersion of the carbonaceous phase and further research is being carried out. Methods 2 and 3 proved to be unacceptable. Method 4, which includes roasting at 300 to 400°C, is now being operated on an industrial scale. The final method has also shown definite advantages for particular deposits of high-montmorillonite-content material. (auth)

18892 RECOVERY OF URANIUM IN MINE WATERS. Sugier, P. (CEA, Chatillon-sur-Bagneux, France). pp 96-100 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967. (In French).
See STI/PUB-146.

The date on which leaching was first observed in the CEA mines is indicated and the main factors necessary for, or favorable to, the solubilization of uranium in mines are listed. Information is given on the various sources of this type at present identified in France and on the methods used to recover uranium in mines situated near ore-concentration plants. An explanation is given for the use of the calcium precipitation technique in connection with waters produced in mines not situated near ore-concentration plants. Data are given on the results of laboratory tests carried out on waters containing uranium, together with a description of an industrial-scale facility built in consequence of these tests. Details are given of the statistical results obtained. The program that will be implemented in the near future with a view to increasing the tonnage of uranium produced by in situ leaching is outlined and the prospects of this low-cost method of producing uranium are considered. (auth)

18893 TREATMENT OF URANIUM ORES BY NATURAL LEACHING IN PORTUGAL. de Lacerda, J. (Junta de Energia Nuclear, Lisbon). pp 101-18 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967. (In Spanish).
See STI/PUB-146.

The technique described for treating uranium ores by natural ores by natural leaching was developed as a result of research carried out in Portugal with a view to determining and eliminating the causes of uranium migration in ores stored in the open. With the natural leaching method, which was successfully applied to primary uranium ores, the ore is piled up on a waterproof surface and sprayed intermittently with mine water. Pyrite and ferrous sulfate are used as solid reagents and are mixed with the ore in amounts averaging 0.4 and 0.2%, respectively. Over 70,000 tons of ore with a U_3O_8 content between 0.076 and 0.150% were treated at five natural leaching plants. The average recovery in these operations was between 57.7 and 85.9%. The average cost was \$3.31/lb U_3O_8. (auth)

18894 PRODUCTION OF HIGH-PURITY URANIUM AT A SOUTH AFRICAN GOLD MINE. Faure, A.; Finney, S.; Hart, H. P.; Jordaan, C. L.; van Heerden, D.; Viljoen, E. B.; Robinson, R. E.; Lloyd, P. J. D. (National Inst. for Metallurgy, Pelindaba, South Africa). pp 119-42 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967.
See STI/PUB-146.

The chemistry of the Bufflex solvent-extraction process is described. Uranium is extracted by a tertiary amine solvent, from which the impurities are removed by means of dilute ammonia, and the uranium is stripped by ammonium sulfate. In the pilot plant, these processes are carried out in mixer-settlers. Details of pumps, flow controllers, and construction materials are given. The operations of the extraction, scrub, strip, precipitation and thickening, and regeneration sections are described. Comparative tests on the elution of ion-exchange resin with 10% sulfuric acid, and with nitrate, are described. The results of resin analyses and plant tests are given. A breakdown of the costs of reagents in the Bufflex process, compared with the conventional process, is given. It was concluded that a solvent-extraction process treating the sulfuric acid eluate from ion-exchange columns is technically feasible. With regard to resin itself, elution with 10% sulfuric acid is satisfactory. There is more polythionate build-up than with nitrate elution, and the capacity of the resin is slightly lower, but the difference is small. The operating cost of the Bufflex process is cheaper by at least 5¢/lb U_3O_8 produced. The product satisfies the most stringent specification for nuclear-grade uranium, except as regards cobalt, molybdenum, silicon, and hafnium. (auth)

18895 INVESTIGATIONS ON THE NATURE AND PHYSICAL CONCENTRATION OF SPANISH URANIFEROUS QUARTZITES. de Lora, F. (Junta de Energia Nuclear, Madrid). pp 143-56 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967. (In Spanish).
See STI/PUB-146.

A study was made of a sample of radioactive material from Santa Elena (Jaen) containing 130 ppM U_3O_8, 300 ppM ThO_2, 4.96% ZrO_2 and 14.29% TiO_2. Over 150 million tons of material were examined. In the light of the studies carried out the material can be defined as a rutilo-zirconiferous quartzite with a double radioactivity source due to the uranium enclosed in the zircon lattice structure and to the presence of monazite. The possibility of brannerite or davidite being present can be discarded. There is likewise no conclusive evidence of the presence of sphene, rutile being the most abundant titanium mineral. The features of the ore were determined with a view to its physical concentration and applied magnetic and gravimetric separation and the flotation process. The use of oleic acid as collector permitted good zircon recovery. (auth)

18896 SPANISH RADIOACTIVE LIGNITES; NATURE AND SOLUBILITY OF THE URANIUM. Josa, J. M.; Merino, J. L.; Villoria, A. (Junta de Energia Nuclear, Madrid). pp 157-71 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967. (In Spanish).
See STI/PUB-146.

The features of some 70 samples of radioactive lignites from various places in Spain (Huesca, Lerida, Teruel, Galicia, and Marcia) with uranium contents varying between 20 and 1200 ppM are described. Experiments were carried out on extraction of uranium from these ores both by direct treatment and after roasting to eliminate organic matter and bring about concentration. The acid method was considered for leaching of the uranium from the substances in question using agitation and static-bed techniques. Investigations were also carried out on the effect of the variables represented by grain size, amount of acid, temperature, time, and oxidants, in addition to those involved in the roasting process. (auth)

18897 STATIC LEACHING OF SPANISH URANIUM ORES. Cordero, G.; Gasos, P.; Merino, J. L.; Suarez, E. (Junta de Energia Nuclear, Madrid). pp 172-92 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967. (In Spanish).
See STI/PUB-146.

Experience acquired in Spain during seven years of investigation on the static leaching of uranium ores is summarized. The operations covered minerals showing wide variations with regard to both uranium content (250 and 2000 ppM) and the type of rock and gangue (granites, shales, sandstones, sulfides, carbonates, limonites, etc.). The studies were carried out on quantities of material varying from a few kilograms to several tons. Leaching agents included water, solid reagents (pyrites), alkaline carbonates, and sulfuric acid. The systems used consisted of both simple layouts and other, more elaborate schemes including recycling of the liquors. The uranium was recovered from the liquors first by direct precipitation and later by ion exchange and extraction with amines. (auth)

18898 RANSTAD: A NEW URANIUM-PROCESSING PLANT. Peterson, A. (AB Atomenergi, Stockholm). pp 193-209 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967.
See STI/PUB-146.

Decisions concerning erection and operations of the Ranstad mill, which was recently kept in operation, are outlined. The geological conditions and the planning of the mining system, plant location, and the factory are described. Processes and equipment of the plant, which has a capacity to treat 850,000 tons of low-grade ore (alum shale) per year, are discussed. The operational experience is also reviewed. The economy of uranium production at Ranstad is discussed and some development possibilities are indicated. (auth)

18899 UNDERGROUND LEACHING: A METHOD FOR THE ECONOMIC EXTRACTION OF URANIUM FROM LOW-GRADE ORES. Zefirov, A. P. (State Committee for the Utilization of Atomic Energy, Moscow). pp 210-15 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967. (In Russian).
See STI/PUB-146.

The method of underground leaching of uranium ores has a number of advantages over extraction followed by processing of the ores in factories. It was studied in two types of deposits, those in rock masses and sandy shales. Research techniques were worked out accordingly for the leaching of uranium from large-grained ore (~200 mm) and from layers in natural stratification. Special models were constructed permitting the simulation of underground leaching conditions. The results obtained were checked in field conditions on experimental plots and experimental underground

blocks. The investigations demonstrated the practicability of the process of underground leaching of uranium from certain ores and made it possible to work out flowsheets and routines for an industrial process, information about which is given. (auth)

18900 RECOVERY OF URANIUM FROM LOW-GRADE SANDSTONE ORES AND PHOSPHATE ROCK. Kennedy, R. H. (Atomic Energy Commission, Washington, D. C.). pp 216-26 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967.
See STI/PUB-146.

Commercial-scale experience in the United States in the recovery of uranium from low-grade sources is considered. Most of these operations were conducted by the operators of uranium mills as an alternative to processing normal-grade ores. The operations were generally limited, therefore, to the treatment of low-grade materials generated in the course of mining normal-grade ores. In some circumstances such materials can be treated by simplified procedures as an attractive source of additional production. The experience gained in uranium recovery from phosphate rock is treated in some detail. The land pebble phosphate rock of central Florida generally contains about 0.01 to 0.02% U_3O_8. While no uranium is being recovered from this source at the present time, it does represent a significant potential source of by-product uranium production because of the large tonnages being mined. (auth)

18901 RECOVERY OF URANIUM FROM URANIUM MINE WATERS AND COPPER ORE LEACHING SOLUTIONS. George, D. R.; Ross, J. R. (Salt Lake City Metallurgy Research Center, Utah). pp 227-34 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967.
See STI/PUB-146.

Waters pumped from uranium mines in New Mexico are processed by ion exchange to recover uranium. Production is approximately 200 lb U_3O_8/d from waters containing 5 to 15 ppM U_3O_8. Recoveries range from 80 to 90%. Processing plants are described. Uranium was found in the solutions resulting from the leaching of copper-bearing waste rock at most of the major copper mines in western United States. These solutions, which are processed on a very large scale for recovery of copper, contain 2 to 12 ppM U_3O_8. Currently, uranium is not being recovered, but a potential production of up to 6000 lb U_3O_8/d is indicated. Ion-exchange and solvent-extraction research studies are described. (auth)

18902 U. S. AEC'S NEW STANDARD TABLE OF ENRICHING SERVICES FOR URANIUM HEXAFLUORIDE. Nozawa, Reikichi (Tokyo Inst. of Tech.). Nippon Genshiryoku Gakkaishi, 10: 75-84(Feb. 1968). (In Japanese).

USAEC has recently revised its standard table of enriching services. The new schedule of base charges for enriched and depleted uranium in the form of UF_6 can be computed according to formulas in the theory of ideal cascade on the basis of taking natural uranium having an assay of 0.711 wt % ^{235}U as having a zero separative work component and on the basis of a tails assay of 0.20 wt % ^{235}U. No optimization of the size of stripping section is made in the schedule. An estimate of separative work costs and capacities of enriching facilities in UK, France and Red China is included. (auth)

18903 SOLVENT EXTRACTION OF NIOBIUM AND TANTALUM. V. SEPARATION OF NIOBIUM AND TANTALUM WITH TOA AND SOME N-SUBSTITUTED LONG CHAIN AMINES. Djordjevic, C.; Sevdic, D. (Univ. of Zagreb). Croat. Chem. Acta, 39: 155-63(1967).

Separation of niobium and tantalum by solvent extraction with di-n-octylaminoethanol (DOAE), di-n-octylaminopropanol (DOAP), di-n-octylaminobutanone (DOAB), di-n-octylaminoacetic acid (DOAA), di-n-octylamine (DOA), and tri-n-octylamine (TOA) in chloroform is described, in the metal concentration range of 10^{-5} M. Separation can be achieved in 0.2M HF metal solutions in the sulfuric acid concentration range from 1 to 5M. Tantalum is extracted into the organic phase and can be stripped back easily with 1 to 6M hydrochloric acid. Niobium and tantalum of radiochemical purity are obtained. The separation factors displayed by these extraction reagents are compared and discussed. (auth)

18904 PURIFICATION OF HIGHLY MINERALIZED RADIOACTIVE WATER IN INSTALLATIONS WITH EVAPORATORS IN THE ATOMIC POWER STATIONS. Matskevich, G. V. Teploenergetika, No. 10, 18-23(Oct. 1967). (In Russian).

The purification of waste water is achieved by coagulation of highly mineralized water in evaporators and separation of the calcium carbonate residue. Primary and secondary foaming interfere with the purification process. Primary foam formation is suppressed by the decrease of the coefficient of multiplicity of the circulation of the concentrated solution (hydrodynamic method). Suppression of the secondary foam formation is accomplished by chemical methods using foam absorbers in the scrubber on the lower evaporation plate. Pre-purification of the distillate from evaporators on an ion-exchange filter is the most effective method of increasing the degree of purification of the water. The purified distillate from Ionite filters can be used to supply the first and second circuit systems in nuclear reactors. (tr-auth)

18905 SEPARATION OF ^{95}Zr FROM ^{95}Nb, AND THE SEPARATION OF ^{95}Zr AND ^{95}Nb FROM SEVERAL OTHER NUCLIDES. Marsh, Richard H. (Ford Motor Co., Dearborn, Mich.); Hahn, Richard B. Anal. Chem., 40: 641-3(Mar. 1968).

By using a lithium-drifted germanium detector, the separation of ^{95}Zr from ^{95}Nb can be tested. To a solution of fission products, carriers are added and the solution brought to 100 ml with 2.5M HCl. Ammonium phosphate is added and the solution is digested before centrifugation. The precipitate is zirconyl phosphate. To the remaining solution containing soluble peroxyniobic acid, 50 ml of nitric acid is added and the solution is boiled until niobium phosphate precipitates. Results of the study are presented as decontamination factors calculated from peak height ratios. (M.C.G.)

18906 THE DURABILITY OF GLASS FOR THE DISPOSAL OF HIGHLY RADIOACTIVE WASTE. DISCUSSION OF METHOD AND EFFECT OF LEACHING CONDITIONS. Elliot, M. N.; Auty, D. B. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Glass Technol., 9: 5-13(Feb. 1968).

A new leaching technique is described for measuring the very low leach rates of elements such as strontium and cesium from glasses. The basis of the technique is to leach grains of glass containing γ-emitting isotopes of the elements of interest, and to determine automatically by γ spectrometry the activity in the leach solution. The simultaneous rates of removal of cesium, strontium, cerium, and terbium from two borosilicate glasses and one phosphate glass were measured using seawater and distilled water at temperatures between 30 and 60°C. The effect of the rate of cooling of a glass after its preparation on durability was also examined. Results are expressed in terms of a leach factor, which is the reciprocal of the penetration depth. The results show little effect due to preparation, cooling rate, or leach fluid used. Leach factors for strontium and cesium were similar, but cerium and terbium were a factor of 100 higher. The cesium and strontium leach factors decreased by approximately an order of magnitude as the temperature was increased from 30 to 60°C. The borosilicate glasses were slightly more durable than the phosphate glass, the cesium leach factors being 1 to 4×10^6 and 10^5 to 10^6 weeks/cm, respectively. Determinations of leach factors for silicon, boron, sodium, and phosphorus indicated that a leached silicate layer, rich in fission product oxides, is formed at the glass surface. (auth)

18907 THERMOCHEMICAL STUDY OF THE EXTRACTION OF THE LIGHT LANTHANIDE NITRATES BY TRIBUTYL PHOSPHATE. Nikolaev, A. V.; Afanas'ev, Yu. A.; Starostin, A. D. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Dokl. Akad. Nauk SSSR, 176: 110-12(Sept. 1, 1967). (In Russian).

In spite of the wide use of tributyl phosphate for the extraction of the lanthanides, there are no thermochemical data to explain the reason for the relatively weak temperature dependence of their distribution between the aqueous and organic phases. The problem was investigated by analyzing the various steps that occur during the extraction process with a solution of tributyl phosphate in n-decane, and determining the heat effects calorimetrically. It was found that the values increased from cerium to samarium, exhibiting only slight differences for praseodymium and neodymium. In order to correlate the equilibrium extraction constants and the heat effects, the partition coefficients, α, of cerium, praseodymium, neodymium, and samarium nitrates between the organic and aqueous phases were analyzed; in the absence of direct values for nitrates, the data obtained with chlorides were used. A linear correlation was found within the limits of experimental error, between ΔH and $\log \overline{K}$. Calculation of the heat of the extraction reaction and the enthalpy of solvate formation yielded values that were nearly identical for the lanthanides examined and agreed with previous data obtained by calorimetric bomb measurements. (TTT)

18908 RAPID RADIOCHEMICAL SEPARATION OF RADIOACTIVE PRASEODYMIUM FROM RADIOACTIVE CERIUM. Landgrebe, A. R.; Rodriguez-Pasques, R. H.; Schima, F. J. (National Bureau of Standards, Washington, D. C.). Int. J. Appl. Radiat. Isotop., 19: 147-9(Feb. 1968).

A procedure for the separation of Pr and Ce from praseodym-

ium metal target irradiated at the NBS Linac is described. The praseodymium metal was dissolved in HNO_3 and then divided into two aliquots. One fraction was used to precipitate cerium(IV) iodate, giving an aqueous phase free of Ce radioactivity. A second fraction was extracted with 0.7M solution of bis(2-ethylhexyl) orthophosphate (DEHPA), giving Ce(IV) in the organic phase free of Pr radioactivity. The total time of transfer was 5 min and the time required for the separations was 5 min. The use of DEHPA gave a rapid separation of Ce with a decontamination factor of $>10^5$ for the Ce in the organic phase, but the Pr isolated in the aqueous phase was not radiochemically pure under the conditions used. The method of separation can produce pure Pr; however, the time required makes it unsatisfactory for rapid separation. (D.H.M.)

18909 DISPOSAL OF RADIOACTIVE IMPURITIES. Noble, John H. (to Stone and Webster Engineering Corp.). British Patent 1,103,365. Feb. 14, 1968. Filed Oct. 7, 1966.

Radioactive contaminants are removed from a mixed bed of cation and anion exchange resins by passing an aqueous solution of an alkali metal halide through the contaminated resin bed in both directions. The water is then removed to leave a small quantity of solid radioactive waste materials in readily disposable form. (B.L.M.)

18910 FLOTATION PROPERTIES OF RARE METAL MINERALS. Plaksin, Igor N. (ed.). New York, Primary Sources, 1967. 94p. $8.75.

Translation of Flotatsionnye Svoistva Mineralov Redkikh Metallov, by R. E. Hammond.

Topics covered include: flotation of tungstite-bearing cross; the effect of illumination on the flotation behavior of minerals with semiconductor properties; flotation properties of sturverite, tantalite, and microlite; pyrogallol as a regulator in nonsulfide mineral flotation; use of potassium permanganate to separate sulfide concentrations; selective desorption of sodium oleate from pyrochlore, zircon, and monazite by sodium sulfide; flotation of silicates and oxides with a mixture of short-chain fatty acids; reaction of sodium sulfide with pyrochlore, zircon, and monazite in flotation with sodium oleate; and study of forms of oleic acid attachment and grain aggregation in oxidized minerals by infrared spectroscopy. (M.C.G.)

18911 PROCESS FOR ELIMINATING FROM A SOLUTION ANIONS DERIVED FROM OXYACIDS. Guth, Jean Louis; Wey, Raymond (to Commissariat a l'Energie Atomique). British Patent 1,102,554. Feb. 7, 1968. Priority date Jan. 27, 1964, France.

Hydroxyparacancrinite is proposed for the extraction of anions derived from inorganic oxyacids from neutral or slightly alkaline aqueous solutions. The exchanger is prepared from a mixture of silica, aluminum hydroxide, caustic soda, and water by heating the mixture for several days at a temperature of 200 to 350°C. (B.L.M.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 18964, 18966, 18996, 19048, 19057–19059, 19063–19075, 19085, and 19178.

18912 (COO–1281–5) STUDIES ON THE DISTRIBUTION OF COBALT IN LAKES. Parker, Michael (Wisconsin Univ., Madison). 1966. Contract AT(11-1)-1281. 84p. Dep. CFSTI.

Thesis.

A study was made of the distribution of cobalt between the liquid and solid (suspended particles) portions in 8 lakes in Wisconsin. Samples were taken from various depths. Seasonal changes in distribution, differences in distribution in various lakes, and evaluations of the causes of various distributions are presented. (J.C.W.)

18913 (HNS–21) GROUND WATER STUDY PROGRAM: AN APPRAISAL OF THE DISTRIBUTION COEFFICIENT FOR ESTIMATING UNDERGROUND MOVEMENT OF RADIOISOTOPES. Kaufman, Warren J. (Hazleton-Nuclear Science Corp., Palo Alto, Calif.). Mar. 1963. Contract AT(29-2)-1229. 26p. Dep. CFSTI.

The distribution coefficient is used to describe the relative affinity of an ion for the solid and liquid phases of an exchange system. It is normally expressed as the ratio of the concentration of a single ionic species or radionuclide on a solid to that in the adjacent liquid. The distribution coefficient is directly proportional to the selectivity of the exchanger and to its exchange capacity. It is inversely proportional to the concentration of competing ions in the liquid. The distribution coefficients of cesium and strontium in natural ground waters are of special interest in ascertaining the radiological hazards of underground nuclear explosions. The rate of transport of these ions is inversely proportional to their distribution coefficients, such that when contaminated waters of low mineral content traverse formations of high clay content, a very significant retardation of the contaminant occurs. In the case of cesium and certain clay minerals, a high degree of selectivity exists which may greatly enhance the retarding influence of the clay, even though the exchange capacity is quite small. The relationship of the distribution coefficient to ground water-clay mineral systems and to the application of these coefficients to estimating the velocities of movement of cesium and strontium is discussed. (auth)

18914 (AWRE-Trans–55) INTERPRETATION OF URANOMETRIC ANOMALIES IN ARID REGIONS BY MEANS OF THE $^{234}U/^{238}U$ ISOTOPIC RATIO. Syromyatnikov, N. G.; Ibraev, R. A.; Mukashev, F. A. Translated by F. E. Wallwork (Atomic Weapons Research Establishment, Aldermaston, Eng.), from Geokhimiya, No. 7, 834-41(1967). 11p. Dep. CFSTI. UK. JCL $1.60 fs, $0.80 mf.

This paper was abstracted from the original language and appeared in NSA as 21: 36115. (L.C.L.)

18915 DETERMINATION OF THE URANIUM AND THORIUM CONTENT IN ROCK AND ORE SAMPLES ON THE BASIS OF FISSION FRAGMENTS. Lobanov, E. M.; Isabaev, E. A.; Yankovskii, A. V.; Abil'daev, A. Kh.; Vasil'ev, V. S. At. Energ. (USSR), 23: 555-7(Dec. 1967). (In Russian).

A method was developed for the determination of the concentration of fissionable elements in ore and rock samples by taking advantage of the ability of actinide elements, which under the geological conditions include only uranium and thorium, to undergo fission at low excitation energies. The ~1.50×10^8 n/cm^2 sec horizontal beam hole of the VVR-S reactor was used as the neutron source. In the calculations, the fissions of ^{238}U and ^{232}Th by fast neutrons were also taken into consideration. The actual concentration was determined by reference to the count rate of the unknown specimen to that of standard samples with known uranium and thorium contents. A specially constructed ionization pulse fission chamber which made it possible to analyze 16 samples was used in the determinations. It was found possible to determine 2 to 4×10^{-4}% of uranium and 4 to 8×10^{-3}% of thorium during a counting period of 1 to 1.5 hours. If the thorium concentration does not exceed that of uranium by a factor of 10, the latter may be determined with greater precision, as the U/Th count rate ratio is 99.7 ± 3.8. The results were checked by chemical analysis. (TTT)

18916 DATING OF SNOW SAMPLES OF THE BORDER OF ANTARCTICA BY MEASUREMENT OF THE NATURAL AND ARTIFICIAL RADIOACTIVITY. Lambert, G.; Lorius, C.; Ardouin, B. (Centre des Faibles Radioactivites, Gif-sur-Yvette, France. Centre d'Etudes Nucleaires, Saclay, France). Earth Planet. Sci. Lett., 3: 429-33(1968). (In French).

The measurement of the β activity in firn samples from Antarctica to determine the snow accumulation by means of the layer of artificial radioactive fallout formed in the beginning of 1955 is described. The mean annual value of 21 cm water is in good agreement with the measurements made on snow accumulation stakes, while the irregularity of annual snow deposits makes it difficult to use other methods. The fluctuations observed in artificial β activity seem linked not only to nuclear explosions but also to atmospheric processes, as suggested by comparing these fluctuations with those of α activity due to lead-210. (auth)

18917 LENGTH OF FISSION TRACKS AND AGE OF MUSCOVITE SAMPLES. Bigazzi, Giulio (Laboratorio di Geologia Nucleare, Pisa, Italy). Earth Planet Sci. Lett., 3: 434-8(1968).

It has been observed that the etchable length of fission tracks in muscovite depends very closely on geologic age determined by the fission tracks method. The consequences of this fact, and especially its influence on the age calculation, are discussed. (auth)

18918 SEDIMENTATION RATE DETERMINATION IN DEEP SEA CORES BY GAMMA-RAY SPECTROMETRY. Osmond, J. K.; Pollard, Lin D. (Florida State Univ., Tallahassee). Earth Planet. Sci. Lett., 476-80(1968).

Non-destructive gamma-ray spectrometric analysis of deep sea core samples provides a variation on the ionium-excess method of sedimentation rate determination. It is based on the measurement of ^{214}Bi, daughter of ^{230}Th, and profiles of several cores indicate that a 300,000 year time line can be determined. These same profiles give evidence for considerable diffusion of radium near the tops of the cores. Sedimentation rates determined by the gamma method agree in general with thorium-230 radiometric analyses; however, comparison with sedimentation rates determined in the same cores by paleomagnetic polarity epochs suggests that sedimentation rates for the last 300,000 years may have decreased somewhat. (auth)

18919 RADIOISOTOPES AND THE PROTACTINIUM AGE OF NEOVOLCANIC ROCKS OF THE CAUCASUS. Cherdyntsev, V. V.; Kuptsov, V. M.; Kuz'mina, E. A.; Zverev, V. L. (Geological Inst., Moscow). Geokhimiya, No. 1, 77-85(Jan. 1968). (In Russian).

A method for the determination of the maximum age of neovolcanic rocks is proposed based on a geochemical effect. This effect lies in the fact that most of the uranium is supplied to volcanic earths without products of decay in the late phase of their existence. The Holocenic time of activity of some volcanoes in the Caucasus is confirmed and regularities of uranium and thorium behavior as well as products of decay: ^{234}U, Pa, Io, RdTh are shown. (auth)

18920 LEACHING ON ^{90}Sr FROM SOME SOILS AND GROUNDS. Koloskov, I. A.; Pisarev, V. V.; Sinitsyna, Z. L. Pochvovedenie, No. 2, 87-93(Feb. 1968). (In Russian).

Data are presented on horizontal and vertical leaching of soils contaminated with soluble strontium-90 compounds. It was established that the leaching of this isotope depends on physicochemical properties and composition of the soils and amounts to 1 to 5% in the above stated experiments. (auth)

18921 FURTHER APPLICATIONS OF CONCORDIA PLOTS TO ROCK LEAD ISOTOPE ABUNDANCES. Russell, R. D.; Slawson, W. F.; Ulrych, T. J.; Reynolds, P. H. (Univ. of British Columbia, Can.). Earth Planet. Sci. Lett., 3: 284-8(Jan. 1968).

The application of concordia-type plots to the interpretation of the isotopic abundances of lead in rocks and minerals, as proposed by Ulrych is described. Additional examples are examined, including leads from Balmat, New York, and from the Vesuvius, Italy. In all cases the data are obtained from the published literature. It is pointed out that the procedures can be extended to evaluate the $^{238}U/^{204}Pb$ ratios for the first stage of the two stage model assumed. The values thus obtained for the data available are in surprisingly good agreement and, when normalized to the same value for the age of the earth, give a mean value for the eight suites of samples equal to 8.70 ± 0.12. This value is compared with values found by Ostic, Russel and Stanton and it is concluded that any systematic difference might be accounted for by discrimination in the mass spectrometer techniques. (auth)

18922 ^{230}Th DATING OF VOLCANIC ROCKS. Taddeucci, Adriano; Broecker, Wallace S.; Thurber, David L. (Columbia

Univ., Palisades, N. Y.). Earth Planet. Sci. Lett., 3: 338-42(Jan. 1968). (CU-3139-1(App.E)).

Measurements of ^{238}U, ^{232}Th, and ^{230}Th have been made in separated phases from four of the Mono Craters volcanics and from one of the Inyo Craters. The results show that sufficiently large differences in U/Th ratio exists between the glass and hornblende separates to allow dating of these eruptions. Suggested ages for the Mono Craters range between 2000 and 10,000 years, and show a general agreement with K-Ar ages and geological evidence. The Inyo Crater sample has an apparent age of 35,000 years, ten times higher than the K-Ar age. (auth)

18923 RADIOACTIVE WASTE DISPOSAL IN ITALY: PRELIMINARY SITING STUDY. Giannotti, G. P.; Mittempergher, M.; Sidoti, G.; Pantanetti, F. (CNEN, Rome). Com. Naz. Energ. Nucl., Notiz., 13: 53-68(Dec. 1967). (In Italian).

A preliminary siting study to locate areas favorable for a permanent installation for the disposal of radioactive wastes in surface ground formations is described. The study is based on a comparative examination of the factors which characterize a natural environment; in particular, consideration was given to all parameters which govern the complex relationship between water, regarded as the potentially best dispersing medium, and the biologic environment. All data collected on the various parameters are summarized in 21 maps in the scale of 1:1,000,000. Most of the maps prepared are novel for Italy and can also be used outside the specific field of radioactive waste disposal. Problems involved in the study of industrial plants, which generally exert harmful effects on the biological environment, are the same which provided the logical guidelines for this research. Some of the most original maps are shown by way of example. (auth)

18924 PROGRESS OF HYDROLOGY. Chow, V. T. (Univ. of Illinois, Urbana). pp 3-20 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

The challenge of hydrology, recent activities, events, and major problems in hydrology, and advances in hydrological techniques are discussed. New scientific knowledge and techniques developed in many modern scientific disciplines, and the recognition of the importance of hydrology in water-resources development enable and encourage the hydrologist to advance scientific hydrology. Many programs to promote hydrology and to expand its attendant activities have been developed in recent years. Therefore, the activities in the United States, such as the Universities Council on Water Resources and the President's Water for Peace Program, and the programs in the International Hydrological Decade are mentioned. The most important advance in theoretical hydrology is the development of a new concept of dynamic sequential systems for the hydrological cycle, thus creating new fields of systems, parametric, and stochastic hydrology. Modern scientific instrumentation provides the hydrologist with better tools for solving his problems. The most important of these, such as electronic computers, remote sensing, and nuclear techniques are discussed. Today various major problems, both theoretical and practical, face the hydrologist. Theoretical problems concern the basic understanding of hydrological systems and the mathematical simulation and physical interpretation of hydrological phenomena. Major practical problems are numerous and diversified, but they are mostly related to the multiple-purpose development of water resources. Four central problematic subjects are discussed; namely, the effects of man on his environment, the dynamics of aqueous flow systems, hydrological transport mechanism, and groundwater hydrology. Also, the use of nuclear techniques in solving various hydrological problems is discussed. It is believed that the application of nuclear techniques would prove extremely valuable in helping solve problems, but their ultimate use in hydrology will depend upon close collaboration between the nuclear scientist and the hydrologist. (auth)

18925 ISOTOPES IN HYDROMETEOROLOGY. Eriksson, E. (International Meteorological Inst., Stockholm). pp 21-33 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

In recent years rather comprehensive studies have been made of the occurrence and distribution in time and space of tritium, deuterium, and ^{18}O in precipitation and atmospheric moisture. Tritium, the radioactive hydrogen isotope, has been injected into the atmosphere, especially during hydrogen bomb tests, in enormous quantities as compared with the natural production in the atmosphere. Because of its radioactivity it can be used as a tracer in the circulation of water in nature, and can, under special circumstances, reveal features of this circulation which are otherwise not easily studied. Deuterium and ^{18}O in natural waters are subject to fractionation processes during their transport between the earth's surface and the atmosphere. These processes are sometimes easily interpreted and can yield valuable information on particular parts of the water circulation. However, the fractionation processes are often complicated by subsequent mixing processes in the atmosphere, which makes interpretation more difficult. (auth)

18926 HYDROGEN ISOTOPES IN HYDROLOGICAL STUDIES IN ICELAND. Arnason, B.; Sigurgeirsson, Th. (Univ. of Iceland, Reykjavík). pp 35-47 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

The deuterium content in monthly samples of precipitation at Reykjavík, Iceland, has been measured continuously for the past 8 yr. The results show considerable fluctuations for individual months and a slight annual variation. At another station in southwest Iceland deuterium measurements have been carried out for two years. Numerous water samples from cold springs in southwest Iceland show no time variation in deuterium content, whereas samples taken from streams in the same area show a small variation. Cold springs and rivers have similar deuterium content as the total yearly precipitation in their recharge area as judged from monthly samples. Because the time variations are small, these sources are very useful indicators of the mean deuterium content in the precipitation and its variation with geographical position. A map showing the mean deuterium content of precipitation in southwest Iceland is presented. This map is based on cold-surface and near-surface water samples. It shows clearly how the deuterium content varies with the distance from the sea and how the distribution is modified by the landscape. A number of deuterium analyses of thermal subsurface waters is presented with a discussion of the sampling technique for thermal water. Samples of steam and liquid water from some boiling boreholes show that equilibrium is achieved between deuterium concentrations in the vapour and the water phase. This makes it possible to calculate the deuterium content of the recharge water for a hot spring from deuterium measurements of the water phase alone, if the base temperature of the recharge water is known. Our results give no reason to believe that the thermal water changes the deuterium content during its passage underground. In Iceland hydrological conditions are such that deuterium analysis can be used to trace the recharge area of thermal springs. In many cases they differ markedly in deuterium content from the precipitation at their location. The conclusion drawn is that the hot water emerging from some of the hot springs and boreholes in southwest Iceland has flowed under ground for a distance of 50 km or more. (auth)

18927 MODIFICATION OF THE ISOTOPIC COMPOSITION OF RAINWATER BY PROCESSES WHICH OCCUR BEFORE GROUNDWATER RECHARGE. Gat, J. R.; Tzur, Y. (Weizmann Inst. of Science, Rehovoth, Israel). pp 49-60 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

The isotopic composition of groundwaters differs from that of the average rain composition due to selection (seasonal or otherwise) from among different rainfalls during the replenishment of groundwaters, as well as to isotope fractionation which accompanies some of the steps in the recharge process. An assessment of the resulting concentration changes is required before one can use the characteristic variations of the isotopic composition of atmospheric waters as hydrological tracers to mark the origin of groundwaters. An overall measure of the encountered effect is obtained by comparison of the isotopic composition of rain and groundwaters in regions in Israel of known hydrological pattern and recharge areas. Correlation of the effects with the environmental factors of the different areas gives preliminary clues concerning the causes of fractionation which operate in the natural process. Of these the formation of puddles after rain seems particularly effective. The following water transport processes, all of which are steps in the rain-to-groundwater transition, are then evaluated regarding their potential contribution to the modification of the isotopic composition: interception by vegetation, open-water evaporation and exchange with ambient vapour from overland flow and surface run-off, evaporation of soil moisture, transpiration and water transport by unsaturated flow in the zone or aeration. The discussion is based partly on theoretical analysis and partly on case studies of isotope separations in open water-bodies and in lysimeter fields. (auth)

18928 ESTIMATING THE TRITIUM INPUT TO GROUNDWATER FROM WINE SAMPLES: GROUNDWATER AND DIRECT RUN-OFF CONTRIBUTION TO CENTRAL EUROPEAN SURFACE WATERS. Roether, W. (Heidelberg Univ.). pp 73-91 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

A model was derived which allows a quantitative evaluation of wine tritium data. It was shown that the tritium content of a wine sample is not determined exclusively by water taken up by the roots, but is also influenced to a large extent by direct exchange with atmospheric moisture. The soil-water fraction amounts normally to not more than 40%. Thus, wine is a sample partly of atmospheric moisture at ground level, partly of soil moisture, integrated over a period around three weeks before vintage. The tritium content of two sets of wine samples originating from two selected sites in the Federal Republic of Germany and dating back to 1949 is reported. For the period since records of the tritium content of rain in Europe have become available comparisons of wine tritium with reported tritium activities of rain are in favour of the model outlined. The first distinguishable influence of bomb tritium showed up in the 1953 wine, but no detectable response to Castle tritium was found in 1954. By comparison with recorded rain activities at Ottawa, Canada, it is concluded that Castle influenced the tritium fallout in Central Europe much less than it did at Ottawa. For the period before 1955 the tritium activity of the annual groundwater recharge, including pre-thermonuclear recharge in Central Europe, is estimated from the wine data. An estimation of the total assimilation of pre-thermonuclear tritium into the ocean at 50°N is also given, which points to a value of 1 to 1.5 atoms/cm^2 s. It is shown that in further uses of pre-thermonuclear wines the possibility that samples have been contaminated by penetration of thermonuclear tritium through the bottle seals must be considered. The estimates of the tritium activities of groundwater recharge are based on the fact that in our climate the main contribution to groundwater is made up by autumn and winter precipitation. Because of this correlation with season the groundwater recharge is much lower in tritium than the yearly average of precipitation. This is reflected also by river measurements, which in the absence of a direct run-off contribution, show a surprisingly low tritium content. The Weser river, which has its catchment area in the hilly districts and the lowlands of Northern Germany, is an example of dependence on large groundwater bodies and shows large fluctuations in tritium concentration correlated with rainfall. These fluctuations originate from the varying ratio of direct run-off to groundwater contribution, the direct run-off being much higher in tritium than the groundwater during the period of investigation (1963 to 65). The minimum tritium values for the Weser show that the groundwater contributions in 1964 had an average level as low as, or lower than 150 T.U. Fluctuations in the tritium concentration of the Alpenrhein, the main inflow of Lake Constance, are relatively small. This is obviously due to the fact that in this case the groundwater draining to the river is replaced fast enough to keep the concentrations of direct run-off and groundwater closely similar. Lake Constance, which is layered in summer and mixed in winter, was followed up in its response to the increased atmospheric tritium levels of recent years. The information on internal mixing of the lake thus obtained is compared to the mixing parameters obtained by other methods. The deep-water activity increased from 150 to 450 T.U. between 1963 and 1965. (auth)

18929 DATING OF GROUNDWATER WITH TRITIUM AND ^{14}C. Muennich, K. O.; Roether, W.; Thilo, L. (Heidelberg Univ.). pp 305-20 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

Shallow groundwater can be dated with some accuracy on the basis of its bomb tritium content if the unsaturated soil cover and the aquifer itself is sufficiently homogeneous. A few examples from the Rhine valley are presented. The decrease in tritium level from the water table to a few meters below is nearly two orders of magnitude. Agreement between the measured or estimated variation of bomb tritium in rain during the past decade and the tritium found in shallow groundwater can be obtained if one takes into account that (a) practically no summer rain reaches the water table, and (b) water is mixed by diffusion. Both effects can also be observed in the soil moisture of the unsaturated soil above the water table. Carbon-14 increase in groundwater due to bombs is delayed compared to tritium, the reasons being delay in the biological system and exchange with the carbonate in the soil. Nevertheless lysimeters show a marked increase of ^{14}C, which depends on the plant cover, being high in a plant-covered lysimeter and low in a bare one. A simple model is presented, which allows the evaluation of the influence of exchange on the ^{14}C age obtained. It turns out that the deviation from the true age depends on the ratio of the carbonate content in the aquifer material to the carbonate content of the water, on the specific contact surface or the grain size but not on the groundwater velocity. On the basis of this model the experimental finding that ^{14}C ages are usually in agreement with other age estimates despite the loss by exchange is plausible owing to the fact that only material of sufficiently coarse grain size can make up a reasonable aquifer. Assuming only exchange with a monomolecular surface layer of the carbonate grains one finds that the ^{14}C age is likely to differ by not more than a factor of two in the most unfavourable case. Under natural conditions (steady state of cosmic-ray-produced ^{14}C) the ^{14}C content of shallow groundwater is hardly influenced at all by exchange, even within very finely grained soil. In the case where the ^{14}C level is rising because of bomb testing, a new equilibrium with the monolayer must be established, by which the ^{14}C increase in groundwater is delayed. The extent of carbonate exchange has been studied under laboratory conditions in a column. The delay of the ^{14}C pulse in spiked water under the conditions chosen is such that the spike travels with approximately half the velocity of the water. From this and from the dispersion observed one can conclude that equilibrium with the surface monolayer is reached within a few hours. Further studies at elevated temperatures indicate the extent to which penetration into deep layers must be taken into account. (auth)

18930 MODEL EXPERIMENTS FOR ^{14}C WATER-AGE DETERMINATIONS. Wendt, I.; Stahl, W.; Geyh, M.; Fauth, F. (Bundesanstalt fuer Bodenforschung, Hanover). pp 321-37 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

The ^{14}C age of water samples is calculated by assuming that fossil carbonate is dissolved by biogenic CO_2 according to the equation, $x_1 \cdot CaCO_3 + (x_1 + y_1) \cdot CO_2 + H_2O = 2x_1 \cdot HCO_3 + y_1 \cdot CO_2$, where x and y are the number of moles of the two carbon components before and after the dissolution process. In a closed system the relation, $y_1 = K(T)\ (x_1)^3$, must be satisfied additionally. The equilibrium constant K(T), which depends on the temperature, controls the concentrations of free CO_2 and HCO_3. To investigate the mechanism of the dissolution, laboratory experiments under controlled conditions were carried out. Non-radioactive $CaCO_3$, which had a $\delta^{13}C$ value of +30%, and radioactive CO_2 with $\delta^{13}C = -22\%$ were used. The purpose of these investigations was to check the validity of theoretical assumptions regarding the average ^{14}C activity and the $\delta^{13}C$ value of the total carbon which is dissolved as CO_2 and HCO_3. Furthermore, it was investigated whether, within the duration of the experiment, a possible exchange takes place between the undissolved carbon present in the $CaCO_3$ and that present in the HCO_3. The importance of this lies in the fact that the method of ^{14}C age determination is based on the assumption that such an exchange does not take place. The experiments which have been performed up to now show that in case of the simple $CaCO_3$–CO_2 system, which has been considered first, this assumption is not justified even for a constant water temperature. If variations in the water temperature occur during the history of the water sample, precipitation and redissolution processes influence the ^{14}C and $\delta^{13}C$ values differently. This is due to isotopic fractionation processes between the HCO_3 and CO_2 phase. A correction for the initial ^{14}C activity by means of the $\delta^{13}C$ value is no longer possible, and the reliability of the ^{14}C dating method becomes questionable. (auth)

18931 SURFACE-WATER INFILTRATION AND GROUNDWATER MOVEMENT IN ARID ZONES OF VENEZUELA. Tamers, M. A. (Instituto Venezolano de Investigaciones Cientificas, Caracas). pp 339-53 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

Radiocarbon dating of the carbonate species present in groundwater is capable of furnishing information on the recharge of underground deposits as well as directions and rates of movement. The origins of the dissolved carbonates fall under two classifications: modern carbon is provided by carbon dioxide from the atmosphere and the products of plants in the soil, and ancient carbon comes from dissolving limestone. The latter source is essentially free of radiocarbon and, therefore, causes falsely old dates for the total groundwater carbonates. An estimate of the amount of limestone dilution is the main difficulty connected with radiocarbon dating of groundwater. The methods proposed

for this correction were applied to several aquifers under different conditions. It is seen, with numerous measurements, that the use of naturally occurring ^{13}C would result in important uncertainties. Adjustments of the dates for the limestone contribution employing bicarbonate and total carbon concentrations is considerably more successful and gives reasonable results in the cases studied. Aquifers of Barquisimeto, Maracaibo, Coto, Paraguana, and Valencia in Venzuela were investigated by the method of natural radiocarbon. Ages ranging from modern to 35,000 yr were obtained. In general, the older dates correlate well with arid climatic conditions. However, deep wells providing modern water have been observed in virtual deserts, but these are explained by the reentrance of irrigation water previously extracted from the ground. Infiltrations from rivers and lakes were also studied using wells surrounding the surface-water bodies. The relationship between the amount and the distribution throughout the year of rainfall and evaporation is seen to be important for arid zones. Radiocarbon ages of the various groundwaters, after correction for limestone, are in agreement with the expected situations as deduced from considerations of climatic conditions of the different regions. The practical importance of these studies for the management of the available water supplies in arid zones of Venezuela is discussed. (auth)

18932 INVESTIGATION OF GROUNDWATER FLOW WITH RADIOCARBON. Vogel, J. C. pp 355-69 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

An interesting potentiality of the radiocarbon dating of groundwater is the deduction of recharge rates of aquifers. The relationships between the age at a point in the water-body and the recharge depends on whether the aquifer is confined or unconfined. For an unconfined aquifer receiving recharge over the whole surface area a simple relationship is deduced. Such an aquifer can be characterized by its age at half-depth. Natural radiocarbon has been used to study flow patterns and flow-rates of subterranean waterbodies in different regions in the Netherlands. The deep groundwater in the southeast region of the Usselmeer presents a complicated situation caused by the inhomogeneity of the strata. Flow-rates are therefore not so readily deduced, but the different aquifers can be distinguished by using the isotopes ^{14}C, ^{13}C, and ^{18}O as natural tracers. In the province of Friesland the deep groundwater shows a more consistent picture with flow times of several thousand years corresponding to a quite acceptable flow-rate of around 10 m/yr. A much faster turnover time is observed in the unconfined fresh-water aquifer on the island of Schiermonnikoog. The hydrological parameters as deduced from ^{14}C and tritium measurements compare reasonably well with expectation. (auth)

18933 NATURAL TRITIUM IN GROUNDWATER STUDIES. Theodorsson, P. (Univ. of Iceland, Reykjavik). pp 371-80 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

Since 1952 large quantities of tritium have been injected into the atmosphere from tests with thermonuclear weapons and large variations in the tritium concentration of rain have occurred. These variations are reflected in groundwater in different ways depending on the history of the water. Therefore, tritium measurements can give valuable information about groundwater hydrology. Rain, river water, groundwater and geothermal water from various localities in Iceland have been sampled since 1960, and routine measurements of tritium have been carried out since 1963. The tritium concentration of thermal water from major geothermal areas in Iceland together with some measurements on other groundwater systems is reported. (auth)

18934 TRITIUM AND ^{18}O IN THE EVIAN BASIN. Fontes, J. C.; Letolle, R.; Olive, Ph.; Blavoux, B. (Centre de Recherches Geodynamiques, Paris). pp 401-15 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967. (In French).

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

Isotopic surveys of the Evian basin (precipitation, surface system, test wells and springs) have been going on since 1962. Measurement of ^{18}O and tritium content have made it possible to determine the mean height of the drainage area and to consider various hypotheses in connection with the hydrodynamics of the water table. It has also been possible to determine the behavior of recent meteoric water and its possible contribution to the water-table supply. The data derived from hydrological studies are in good agreement with the set of isotopic results. The isotopic measurements have also been used to plan the catchment area equipment and to fix the test-well sites. In view of the theoretical and even economic importance of such coordinated isotopic studies, a proposal is made that systematic sampling be organized on an international scale on the site of the main catchment areas presenting serious hydrogeological problems. (auth)

18935 TRITIUM HYDROLOGY IN NEW ZEALAND. Grant-Taylor, T. L. (Geological Survey, Lower Hutt, New Zealand); Taylor, C. B. pp 381-400 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

Knowledge gained from the study of post-thermonuclear concentrations of THO in New Zealand rainwaters has been applied to the interpretation of the measured concentrations in a number of underground and surface waters. The results indicate that significant conclusions can be derived from the small concentrations and concentration changes experienced in the New Zealand environment in the decade succeeding the first atmospheric thermonuclear contamination. The Heretaunga Plains and Hutt Valley artesian systems are discussed in some detail. The former is a particularly simple system whose geometry allows mathematical expressions to be derived relating the tritium concentrations in wells tapping the main, shallowest aquifer to the distances of these wells from the aquifer input, in terms of the various aquifer parameters. By requiring consistency between the time of appearance of post-thermonuclear THO in the input, the known values of the aquifer parameters and the measured concentrations in a number of wells during 1957, it becomes possible to estimate travel times and also to place limits on the mean prethermonuclear concentration of tritium in New Zealand rainwaters. In the latter system, comparison of the concentrations of river and artesian waters over a period of some years allows an exact determination of aquifer travel time to the main withdrawal point. Measurements, which are in good agreement with geological evidence, are reported for waters taken from different levels of a test bore penetrating the different strata of the system. Waters from the Waikato–Hauraki artesian system, where the sediments are much finer than those of the Heretaunga Plains and Hutt Valley systems, are found to be prethermonuclear in origin. Measurements are reported for stream water from the Wairakei geothermal area indicating a spring recharge of considerable age and only small amounts of surface runoff. (auth)

18936 EVOLUTION OF TRITIUM ACTIVITY IN THE SOUTH-WEST OF FRANCE. Leveque, P.; Vigneaux, M.; Alvinerie, J. (Faculte des Sciences, Bordeaux). pp 417-32 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967. (In French).

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

The tritium activity of rain, lake and underground waters has been under investigation in the Bordeaux area (southwest France) since 1964. The 250 or so analyses carried out show that changes in activity of rain water vary rather considerably, with a fairly marked over-all decrease over the period of about 30 months during which observations have been in progress. One of the lakes in the dunes along the coast of Aquitaine, Lake Cazaux, represents a special case by virtue of its hydrological and hydrodynamic features. The fact that this lake, with an area of about 60 km^2, has no notable source of supply other than precipitation makes it a seasonal integrator of the wide variations in the level of tritium activity in rainwater. A comparison with other lakes seems to confirm this hypothesis. Finally, a considerable lapse of time was found before periods of maximum rainfall were followed by an increase in the activity of surface water layers. The mean activities of some plants are similar to those found in the water of clays and the lake waters. (auth)

18937 TRITIUM AND HYDROGEOLOGY: INVESTIGATIONS AND MEASUREMENTS CARRIED OUT AT THE GRENOBLE NUCLEAR RESEARCH CENTRE. Guizerix, J. (Centre d'Etudes Nucleaires, Grenoble, France); Margrita, R.; Launay, M.; Ruby, P. pp 433-50 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967. (In French).

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

Tritiated water of thermonuclear origin is a new and very interesting parameter of which the hydrogeologist is making increasing use in the study of various problems. The results of work in the following fields are presented. Karst hydrology: In the latitudes in which these studies were conducted, the water from precipitation shows an annual maximum of concentration in June. This "signal" can be used to establish correlations between the losses from an aquifer and resurgence about 30 km away, by means of a series of systematic measurements of the precipitation supplying aquifers and springs. These mea-

surements have been valuable in a trial project involving a gamma-emitting tracer; CETA (Network for the collection of atmospheric tritiated water): This network is concerned with the collection and measurement of monthly samples collected at 26 stations spread fairly evenly across France. Its purpose is primarily to constitute a "bank" of samples, or sampling data, for use in any subsequent hydrological studies carried out in France, and secondly, to permit study of the spatial distribution of tritium fallout. Very interesting results in the form of tritium isoconcentration curves, have disclosed a "sea/continent effect," whereby tritium concentrations increase as one moves inland. These measurements may provide important information on the movements of atmospheric water in France. (auth)

18938 SEASONAL VARIATIONS IN THE TRITIUM CONTENT OF GROUNDWATERS OF THE VIENNA BASIN, AUSTRIA. Davis, G. H. (IAEA, Vienna); Payne, B. R.; Dincer, T.; Florkowski, T.; Gattinger, T. pp 451-73 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

Monthly analyses of tritium from 22 sources of groundwater of the Vienna Basin have been made since April 1965 with a view to elucidating the complex groundwater-surface water relations and ascertaining the movement of groundwaters. The sources are classified broadly into four groups: non-thermal springs including karst springs of the bordering mountains; thermal springs rising along faults that border the floor of the Vienna Basin; wells on the floor of the Basin; and large groundwater overflows on the floor of the Basin. The following are among significant findings: all groundwaters sampled showed the effect of local recharge by high-tritium precipitation in the exceptionally wet summer of 1965; groundwater overflows thought to represent discharge from the main groundwater reservoir were generally higher in tritium than other groundwaters indicating rapid shallow circulation from nearby streams; thermal springs believed representative of deep circulation all showed the effect of mixing with shallow waters recharged from current precipitation; all showed appreciable tritium content, even at the minimum levels; the highest tritium contents in well-waters were from the upper part of the Basin where water levels are very deep and streams lose water in crossing the alluvium; well-waters in the area of shallow water in the lower Basin were generally lower in tritium than those of the upper Basin, but all showed the effect of recharge in the summer of 1965; and samples taken during drilling of a deep exploratory well show a decrease in tritium with depth, but even at 140 m depth the tritium content was 13 T.U. indicating relatively rapid circulation throughout the principal aquifer. (auth)

18939 SOIL-WATER MOVEMENT AND EVAPOTRANSPIRATION; CHANGES IN THE ISOTOPIC COMPOSITION OF THE WATER. Zimmermann, U.; Ehhalt, D.; Muennich, K. O. (Univ., Heidelberg). pp 567-85 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

An artificial rainfall spiked with tritium, marks the boundary between older rainwater below and younger rainwater above. When the tracer mark has reached a certain depth the amount of soil water above the tracer mark gives that fraction of the rain fallen since the date of tracer input, which is still present in the soil. New data on this method are presented. This includes field experiments in sands showing larger dispersion effects than found previously. Larger dispersion is usually combined with a scatter in the position of the tracer maximum in parallel cores. A theoretical discussion of dispersion is given. Among recent improvements in sample processing is a newly developed plant to distill six samples simultaneously, which makes it possible to process several hundred samples a month without much handling. The change in stable isotope composition of the soil water during the downward movement has also been studied in detail. Experiments show that plant transpiration results in practically no isotopic enrichment of the soil water. The considerable average velocity with which the water moves upwards from the root to the leaves through the fine leads of the stem makes this possible despite the heavy enrichment of the water in the leaves. Under Central European conditions a bare soil may, however, show a deuterium enrichment up to about 20% in the top layers. It is obvious that evaporation from the soil, and therefore enrichment, is strongly suppressed by plant cover (grass etc.) especially during summer. This seems to be the reason that the resulting enrichment in densely planted soil is quite small (less than 5% for deuterium). Owing to the lack of a reliable reference value this is difficult to detect. A bare soil under the same conditions as a planted one showed in a number of measurements an extra deuterium enrichment of about 10% on the average compared with the latter. Laboratory experiments on bare-soil evaporation are also presented. With the help of information obtained by tracer experiments on the seasonal variation of groundwater recharge it is now possible to explain the absolute value found for the deuterium content of Central European groundwater. (auth)

18940 FLOW OF A STREAM THROUGH A RESERVOIR. Sauerwein, K. (Gemeinnuetziges Institut, Duesseldorf, Ger.). pp 697-719 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

If a reservoir is fed from a single source, which may not always be pure, the extent to which the inflowing stream mixes with the water in the reservoir is important for the quality of the water supplied by the reservoir. This question was investigated at the Lingese Reservoir, containing between one and two million cubic meters of water, in the Bergisches Land (North Rhine-Westphalia). The investigation was carried out at four different seasons so that the varying effects of the stream-water temperatures could be studied in relation to the temperature of the reservoir water. The stream was radioactively labelled at the point of inflow into the reservoir, and its flow through the reservoir was measured in length and depth from boats, by means of 1-m-long Geiger counters. In two cases the radioactivity of the outflowing water was also measured at fixed points. A considerable variety of intermixing phenomena was observed; these were mainly of limnological interest. The results of four experiments corresponding to the four different seasons are described in detail. They were as follows: the mid-October experiment where the stream, with a temperature of 8.0°C, was a good 5°C colder than the water of the reservoir, whose temperature was almost uniform, ranging from 13.2°C at the bed to 13.6°C at the surface; the spring experiment (second half of March), when the stream temperature was only 0.3°C below that of the reservoir surface (7.8°C), while the temperature of the bed was 5.8°C; the winter experiment (early December) where at first the temperature of the stream was approximately the same as that of the surface so that, once again, the stream at first flowed ½ to 1 m below the surface. During the almost wind-free night a sudden fall in temperature occurred, and the air temperature dropped from 0°C to −12°C; and the summer experiment (end of July to mid-August) when the stream was nearly 1°C colder than that of the bottom of the reservoir. However, the strong fluctuations between the day and night temperatures of the reservoir water produced marked rolling movements. Comparisons were made with simultaneously performed dye and salt experiments, but the four isotope experiments carried out at different seasons were found to be more suitable than the other procedures for investigating limnological processes and evaluating them quantitatively. (auth)

18941 CAPABILITIES AND POTENTIAL OF USAEC'S CURRENT METER FOR ULTRA-LOW-VELOCITY MEASUREMENTS. Elder, R. A.; Vigander, S. (Tennessee Valley Authority, Norris). pp 683-95 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

An analysis of the capabilities and potential of the Deep Water Isotopic Current Analyzer — Model 1B (DWICA-1B) current-velocity and direction meter for use in ultra-low-velocity studies is presented. It operates on the time-of-travel principle using ^{131}I as the tracer. It was used during 1966 on a comprehensive study of the thermohydrodynamics of TVA's Fontana Reservoir. Inflow and outflow conditions in a highly stratified reservoir were studied in considerable detail. Velocities from 0.005 to 0.2 ft/s were present in the flow zones in both the upstream and downstream directions. TVA conducted preliminary tests in 1965 with the DWICA-1 Instrument. The results of these tests indicated that, after certain modifications, a satisfactory instrument would be available. The model 1B instrument was designed and constructed after the 1965 tests to eliminate several problems which developed during the trial tests. Its size and weight and the necessity for a fixed platform from which to make the measurements, plus a lengthy testing time, are DWICA's chief drawbacks. An ability to record velocity and direction under extremely low-velocity conditions with zero inertial characteristics is its major advantage. The availability of this instrument for study of in situ flow conditions in reservoirs and lakes with very low velocities should be of great interest to hydrologists and limnologists since it opens up for study an area for which a usable instrument has not been previously available. (auth)

18942 ISOTOPIC EXAMINATION AT DEPTH OF AN ANTARCTIC GLACIER. Merlivat, Liliane (CEA, Saclay, France); Lorius, C.; Majzoub, M.; Nief, G.; Roth, E. pp 671-81 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967. (In French).

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

Two drillings in the ice of Adélie Land, near a moraine, were made. Two bore samples of ice were taken at 98 m (G_1) and 105 m (G_2). The deuterium contents of the samples from this ice core are between $\delta D = -370‰$ and $\delta D = -40‰$. Between the surface and +54 m, the value of δD varies around $-145‰$ for the two bore samples, which corresponds to the coastal precipitation in that part of the continent. From this, it can be deduced that this layer of ice results from the transformation of the local granular ice. Between +54 and +34 m, δD drops rapidly from $-145‰$ to $-350‰$. Down to −9 m (G_1) and +7.5 m (G_2) δD fluctuates around $-350‰$. On the basis of the topographical data for the area, and the relationship between δD and the annual mean temperature, the origin of this ice on the polar plateau, about 900 km from the coast is explained. Finally, the ice layer in contact with the sediment has a very high δD value reaching $-40‰$ and it is believed to be of marine origin. It is assumed from study of the deuterium that there is an ice flow from the polar cap which passes between a layer of local ice and a layer of marine ice. (auth)

18943 RADIOACTIVITY IN DRINKING WATER IN THE UNITED KINGDOM: 1965 RESULTS. J. Brit. Waterworks Ass., 49: No. 424, 27-33(Jan. 1967).

Samples taken regularly from 26 public drinking water supplies were analyzed for concentrations of ^{90}Sr and ^{137}Cs. The average daily ingestion per person in 1965 was estimated to be 0.95 pCi for ^{90}Sr and 0.19 pCi for ^{137}Cs. (Public Health Eng. Abstr.)

18944 DISTRIBUTION OF RADIUM IN UNDERGROUND WATERS OF CRETACEOUS DEPOSITS OF THE ARTESIAN BASINS IN MIDDLE ASIA. Ergashev, S. E.; Aripova, O. (Inst. of Hydrogeology and Engineering Geology, Ministry of Geology, USSR). Dokl. Akad. Nauk Uzb. SSR, No. 8, 35-7(1967). (In Russian).

A radiohydrogeochemical analysis was made of the mineralization in the water-bearing levels of the lower cretaceous period which showed an elevated radium content in the paleozoic thickness of the district. A longitudinal radiohydrogeological cross section developed from drill holes in 1966 was analyzed. It was found that the waters of the second zone at the depth of 200 to 600 m in the east and 450 to 1000 m in the west have permissible levels of radium only for noncentralized drinking water supplies but the waters of the third level distributed over the the first and second level 200 to 210 m at the west and 350 to 380 m in the east are usable for continuous drinking water supply. (R.V.J.)

18945 RESEARCHES IN GEOCHEMISTRY. VOLUME 2. Abelson, Philip H. (ed.). New York, John Wiley and Sons, Inc., 1967. 673p. $22.50.

Twenty-three chapters are included on topics chosen to provide a cross section of current research activity in geochemistry. Included are: geochronology; variation of $^{18}O/^{16}O$ in minerals and rocks; conversion of biochemicals to kerogen and n-paraffins; organic geochemistry of precambrian rocks; new instrumental techniques in geochemical analysis; meteorite investigations by electron microprobe; chondrules and chondrites; impact metamorphism; rare earth distributions; crystal field theory and geochemistry of transition elements; sulfide studies; associations in petrographic variation diagrams; thermodynamic properties of simple solutions; solution chemistry and metamorphism; genesis of some ground waters from igneous rocks; excess manganese in pelagic sediments; mechanism of deep-sea volcanism in the South Pacific; igneous and metamorphic reactions involving gas equilibria; hydrogen osmosis in hydrothermal experiments; mineral equilibria in the system $MgO-SiO_2-H_2O-CO_2$; phase equilibria at one atmosphere related to tholeiitic and alkali basalts; petrological problems in high pressure research; and high pressure experimental techniques. Author and subject indexes are included. (J.G.B.)

Meteorology

Refer also to abstracts 18925, 18928, 18945, 19012, and 19332.

18946 (A/AC.82/G/L-1196) OPREDELENIE KONTSENTRATSII KADMIYA-109 V PRIZEMNOM VOZDUKHE I VYPADENIYAKH V NEKOTORYKH PUNKTAKH SOVETSKOGO SOYUZA V 1964–1966 GG. (Determination of the Concentrations of ^{109}Cd in the Ground-Level Atmospheric Air and of Fall-Out in Various Points of the Soviet Union in 1964–1966). Fedorov, G. A.; Konstantinov, I. E.; Skotnikova, O. G.; Malakhov, S. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1967. 9p. (In Russian). Dep.

The concentration of ^{109}Cd in ground-level air in the vicinity of Moscow and the fallout levels in three points of the Soviet Union in 1964 to 1966 were reported. The methods for the measurement of the activity of ^{109}Cd were described. The results obtained were compared with the experimental data of other investigators and with the predicted levels of ^{109}Cd in the ground-level air and fallout. (tr-auth)

18947 (BNL-12154) CONTINUOUS LOW LEVEL ENVIRONMENTAL MEASUREMENT OF ^{41}Ar AND OTHER RADIOACTIVE NOBLE GASES. Littlefield, P. S.; Hull, A. P.; Baum, J. W.; Smith, M. E. (Brookhaven National Lab., Upton, N. Y.). [1968]. 25p. (CONF-680108-9). Dep. CFSTI.

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga.

A pressurized beta scintillation monitor capable of the continuous measurement of the small concentrations of radioactive gases which might be encountered in the environment in the vicinity of reactors and other nuclear facilities was designed. Although it can be operated up to 1,000 psig, testing to date has been conducted at 120 psig. At this pressure the monitor's sensitivity to ^{41}Ar is 2.9×10^{10} cpm/μCi/cm^3. The monitor has been employed to verify calculations of hourly average normalized ground level (χ/Q) concentrations of the effluent ^{41}Ar from the BGRR stack. Close agreement between calculated and measured concentrations has been achieved at a location 1,330 meters from the point of release. (auth)

18948 (BNWL-481-1) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT FOR 1966 TO THE USAEC DIVISION OF BIOLOGY AND MEDICINE. VOLUME II. PHYSICAL SCIENCES. PART I. ATMOSPHERIC SCIENCES. Pearce, D. W.; Compton, M. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1967. Contract AT(45-1)-1830. 105p. Dep. CFSTI.

A separate abstract was prepared for the 15 sections in which progress is reported on research in atmospheric sciences at Pacific Northwest Laboratory. (F.S.)

For abstracts of individual sections see: 18949–18963.

18949 (BNWL-481-1, pp 1-4) A BASIS FOR COMPARING EXPERIMENTAL MEASUREMENTS OF LATERAL PLUME GROWTH. Simpson, C. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The dependence of the lateral growth of a diffusing plume on various meteorological parameters was investigated and the relationship between the cross wind exposure variance and the product of the standard deviation of the wind direction and the mean wind speed was found. Experimental tests were used to evaluate the relationship. (F.S.)

18950 (BNWL-481-1, pp 5-8) ELEVATED SOURCE DIFFUSION STUDIES. Elderkin, C. E.; Hinds, W. T.; Sloot, J. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Dual tracer studies to study smoke diffusion in unstable, neutral, and slightly stable conditions were conducted using a source at ground level and at 25.9 m elevation. The source previously used was at 56.4 m so the effect of source height on smoke diffusion was evaluated. Confidence in the use of a single normalized curve has resulted from the cross wind integrated data which were analyzed. The observed dependence on source height is nearly that postulated by the bivariate normal model. (F.S.)

18951 (BNWL-481-1, pp 8-27) TURBULENCE INVESTIGATIONS. Elderkin, C. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Fundamentals of turbulence were analyzed and spectral distributions for the longitudinal and vertical wind components measured during a variety of wind speeds, atmospheric stabilities, and at a number of heights with a fast response heated thermocouple wire wind sensor. Analog computer analysis was completed on the spectral distributions for the lateral component and the cospectral distributions between each of the components. Reynolds stresses were also calculated with an analog computer. (F.S.)

18952 (BNWL-481-1, pp 28-32) WAKE STUDIES. Hinds, W. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The diffusion of pollutants around and near an obstruction, such as a building, was studied. Phenomena such as increased diffusion due to wind direction fluctuations and the atmospheric stability were studied. A ZnS tracer was employed with ground level sources. (F.S.)

18953 (BNWL-481-1, pp 33-43) INSTANTANEOUS PLUME DETECTION. Nickola, P. W.; Elderkin, C. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A device was developed to monitor and record concentrations of a zinc sulfide tracer on a real-time scale to investigate the relationship of the near instantaneous crosswind plume to that of the mean plume and the relationship of the observed downwind plume distribution to the source wind. (F.S.)

18954 (BNWL-481-1, pp 43-52) PRECIPITATION SCAVENGING STUDIES. Engelmann, R. J.; Hagen, D. I. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Measurements of washout coefficients (below-cloud scavenging) for AgI, Br, Cs, I, and Sc are reported. Bromine and I were released as gases; the others as particulates. The washout of organic and inorganic forms of radioiodine vapor in stack effluents is summarized. Washout coefficients for Cs in rain and for AgI, Br, I and Sc in rain and snow are reported. (F.S.)

18955 (BNWL-481-1, pp 53-68) REAL TIME SAMPLING OF AIRBORNE TRACER WITH AIRCRAFT. Dotson, W. L.; Nickola, P. W.; Wolf, M. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Progress in the development of instrumentation and techniques for improved aircraft sampling of a phosphorescent airborne tracer is discussed. The concept and performance of the Airborne Real Time Sampler (ARTS) in diffusion studies are described. (F.S.)

18956 (BNWL-481-1, pp 68-73) SELECTED METEOROLOGICAL ANALYSES OF PLUMBBOB NUCLEAR TESTS. Davis, W. E.; Engelmann, R. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A meteorological analysis of Shot Smoky of the Plumbbob nuclear tests is described. Stream functions on isentropic surfaces (surfaces of constant potential temperature) were analyzed to investigate the horizontal and vertical transport of nuclear debris. (F.S.)

18957 (BNWL-481-1, pp 74-6) IMPROVEMENTS IN RAINDROP CHARGE MEASURING SYSTEMS. Ratcliffe, C. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Improvements made in the earlier equipment are in transducer design, better charge sensitive amplifier stability, and easier field adjustment and operation. The transducer was modified to be more tolerant of breezes during the rain or snow shower being sampled. The charge sensitive amplifier was improved to provide higher gain, more stability, and an easier adjustment procedure than previously. Different cabling, connectors, and power supply arrangements have made field operation and maintenance simpler, especially when the ambient temperature is low. (auth)

18958 (BNWL-481-1, pp 76-8) IDENTIFICATION AND MEASUREMENT OF HYDROGEN CHLORIDE GAS IN THE ATMOSPHERE BY SPECTROPHOTOMETRIC AND RADIOMETRIC ANALYSIS. Ludwick, J. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A radiometric method was developed to measure the long distance hydrogen chloride gas concentrations in the atmosphere. Chloride is precipitated with ^{110}Ag to tag the hydrogen chloride. The method is sensitive to less than 2×10^{-7}g of chloride ion and is adaptable to routine operation. (F.S.)

18959 (BNWL-481-1, pp 78-81) ^{85}Kr AS AN ATMOSPHERIC TRACER. Ludwick, J. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A study of ^{85}Kr as an atmospheric tracer was completed. The gas can be released in a puff or in a continuous stream. Downwind samples of air containing the tracer were readily analyzed by beta-counting, and real-time measurements could be made routinely. (auth)

18960 (BNWL-481-1, pp 82-5) EVALUATION OF ELEMENTAL TRACERS AND NEUTRON ACTIVATION ANALYSES IN ATMOSPHERIC PRECIPITATION STUDIES. Haller, W. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

An evaluation is presented of the use of elemental tracers for atmospheric precipitation studies using neutron activation analysis and Br, I, AgI, Cs, and Sr as tracers. The washout coefficient for Br was ~4. An increase by a factor ten in the amount of Br released is needed. The washout-to-background for I ranged from ~6 to 50 which is within the proper range. Results using particulates indicated that washouts for Cs, Sc, and AgI ranged from 2 to 10. Tracers need to be increased by a factor of 5. The amount of Sr tracer needed because of its high natural background would have to be increased by 2 orders of magnitude for its successful use as a tracer. The methods used for dispersing the tracer and for sampling, preparing, and analyzing the sample are discussed. (F.S.)

18961 (BNWL-481-1, pp 85-7) COSMIC RAY PRODUCED RADIONUCLIDES AS TRACERS OF ATMOSPHERIC PRECIPITATION PROCESSES. Wogman, N. A.; Thomas, C. W.; Cooper, J. A.; Engelmann, R. J.; Perkins, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Using highly sensitive multidimensional gamma-ray spectrometry, the two short-lived cosmic-ray produced radioisotopes ^{38}Cl and ^{38}S were detected in rainwater. The isotopes will be useful in defining precipitation scavenging mechanisms. Techniques were developed for detecting ^{34m}Cl, ^{39}Cl, and ^{24}Na in precipitation. Ratios of these five radionuclides provide information on the scavenging rate and removal efficiency of the atmospheric aerosols to which they are attached. (F.S.)

18962 (BNWL-481-1, pp 87-92) PORTABLE BOOM-TYPE AIR SAMPLER. Ludwick, J. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A completely portable air sampler mast was constructed with vertical sampling capabilities ranging from 0.25 to 12 meters. This mast was installed on a mobile, power-equipped vehicle that allowed air sampling while the vehicle was in motion. The emission plumes from a plant exhaust stack and from reactor effluent water basins were sampled. (auth)

18963 (BNWL-481-1, pp 93-101) DISTRIBUTION, CHARACTERISTICS, AND BIOTIC AVAILABILITY OF FALLOUT, OPERATION PLUMBBOB. Larson, K. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The amount of man-made radioactivity distributed in the environment that can be safely tolerated by man; fallout patterns; the chemical, physical, and radiological characteristics of fallout relative to particle size and occurrence within the fallout pattern; the biotic availability; rate of accumulation and retention in plants and animals; and the distribution of residual contamination in the total NTS environment was studied. (F.S.)

18964 (BNWL-SA-1606) EVALUATION OF ENVIRONMENTAL RADIATION EXPOSURES IN THE VICINITY OF HANFORD. Soldat, J. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 15, 1966. Contract AT(45-1)-1830. 31p. Dep. CFSTI.

The radioactive materials that are released by the Hanford atomic energy facilities to the Columbia River and the atmosphere have been under continuous surveillance since the plants were started up and have been traced through the exposure pathways of potential radiological significance to people that live in the vicinity. Detailed evaluations of the probable doses received by various people have been made through a knowledge of the concentrations of individual nuclides present in water and foods, a knowledge of the habits of the people, and through measurements made with whole-body counters. These exposure evaluations confirm that the total dose to members of the public has always been within appropriate limits, and that the radioactive wastes generated by the plants have been under sound and continuous control. (auth)

18965 (DPST-68-30-1) EFFECT OF THE SAVANNAH RIVER PLANT ON ENVIRONMENTAL RADIOACTIVITY. Semiannual Report, July-December 1967. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Contract AT(07-2)-1. 19p. Dep. CFSTI.

The results of the environmental monitoring program for the atmosphere, vegetation, milk, and water are given for July 7 through Dec. 31, 1967. The quantity of radioactive waste released by the Savannah River Plant to its environs was too small to be distinguished from natural background radiation or was obscured by fallout from offsite sources. Beta activity in air, which showed no relationship with plant operations, was about one-third of that for the same period of 1966 and was the lowest average ever observed at this site. Radioactive materials in fish flesh continued to be far below levels considered significant from a health standpoint. The average concentration of radionuclides in river water at Highway 301 did not exceed 0.25% of the Maximum Permissible Concentrations. (auth)

18966 (GAT-553) ENVIRONMENTAL RADIATION LEVELS AND CONCENTRATIONS. Second Half and Annual Summaries, 1967. Kalmon, B.; Hulett, S. H. (Goodyear Atomic Corp., Piketon, Ohio). Feb. 8, 1968. Contract AT(33-2)-1. 16p. Dep. CFSTI.

The average environmental radiation and concentration levels for the Goodyear Atomic Corporation gaseous diffusion plant, for the second half of 1967 and for the calendar year 1967, are summarized. The results for the first half of 1967 have been previously reported but are also included in tabular form. For the

second half of 1967, the water beta-gamma and the background exposure increased over the first half values. The air alpha, air beta-gamma, and the water alpha remained essentially unchanged. For calendar year 1967 versus calendar year 1966, all values remained unchanged except for the water beta-gamma value which increased significantly. However, the 1967 value is only 0.24% of the AEC concentration standard. Penetrating background dose rates remained unchanged from the 1966 values. In the calculations all of the exposure rates were assumed attributable to plant operations. As in the past, however, the off-site and on-site patterns are very much alike in form and intensity with no significant difference between average values. Based on the on-site and off-site intensities, it is evident that the plant operations have not added appreciably to the general background penetrating radiation. (auth)

18967 (LA-DC-9093) STATISTICAL NATURE OF THE RADIOACTIVE EFFLUENT FROM GROUND TESTS OF NUCLEAR ROCKET ENGINE PROTOTYPES. Fultyn, Robert V. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 34p. (CONF-680108-4). Dep. CFSTI.

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga.

The immediate consequences of the release of radioactive material to the atmosphere due to ground testing of nuclear rockets were evaluated with data from ten rocket firing tests. Measurements were made of the air dosage of radioactive material, the doses due to the radioactive clouds, and the amount of deposited material. The sampling and monitoring procedures are described. The effects of meteorological variables are discussed. The results for each rocket firing are tabulated to show the characteristics of the effluent cloud, the gross radioactivity, the dosages of ^{133}I and ^{135}I, the distribution of deposition velocities of gross activity, and the specific activities of both ^{133}I and ^{135}I. (L.C.L.)

18968 (LA-DC-9094) PROBABILISTIC SCHEME FOR PREDICTING AND EVALUATING HAZARDS RESULTING FROM RADIOACTIVE EMISSIONS TO THE ATMOSPHERE. Fultyn, Robert V. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 23p. (CONF-680108-5). Dep. CFSTI.

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga.

A probabilistic analysis scheme for predicting and evaluating hazards resulting from radioactive emissions to the atmosphere is presented which will allow a greater number of variables to be included in the evaluation. Therefore, it is believed to be a more accurate method than the present system based on limited samplings of fission products. (L.C.L.)

18969 (NP-17269) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 5, Number 10. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Oct. 1967. 21p. Dep.

The program of fallout monitoring includes analyses of air particulates, atmospheric precipitation, and milk for September 1967, in Canada. Total beta activity in air and precipitation samples is determined by using gas-flow type Geiger counters. Analyses of fallout for strontium-90 and cesium-137 in precipitation and strontium-90 in liquid milk are performed radiochemically. (J.C.W.)

18970 PHYSICOCHEMICAL PROPERTIES OF FALLOUT PARTICLES IN RELATION TO BURST CONDITIONS. Mamuro, T. (Radiation Center of Osaka Prefecture). Atompraxis, 14: 24-8(Jan. 1968).

Physico-chemical properties of highly radioactive fallout particles which were collected in Japan shortly after Soviet or Chinese nuclear explosions are described and discussed briefly in relation to burst conditions. Considerable differences in nature are found between fallout particles from air bursts and those from surface bursts with respect to shape, color, matrix material, specific activity, relation between the initial atom number of the radionuclide and the particle volume, radionuclide fractionation, and U and Pu content. (auth)

18971 AIRPLANE MEASUREMENT OF GLOBAL FISSION FRAGMENT CONTAMINATION OF A TERRITORY BY DETERMINING THE GAMMA-RAY SPECTRUM. Boltneva, L. I.; Dmitriev, A. V.; Kogan, R. M.; Ionov, V. A.; Nazarov, I. M.; Fridman, Sh. D.; Yakovlev, A. F. Izv. Akad. Nauk SSSR, Fiz. Zemli, No. 2, 114-19(1967). (In Russian).

The gamma-spectral airplane method used for the investigation was previously described (Sovetskaya geologiya no. 10, 1963). It is claimed that this method gives, compared with summary methods, additional information on the radioisotopic composition of fragment contamination, necessary for establishment of biological danger points. The method is based on definite correlations existing between the depth distribution of the fission fragments in the ground and altitude variation of the gamma radiation in air at definite altitudes above the contaminated territory. The measurements were made with a scintillation gamma spectrometer based on a 100 channel pulse-height analyzer (AI-100-1), carried by airplane (AN-2). The apparatus and the operating procedure are briefly described. Samples of gamma spectra obtained for recently contaminated ground and for ground that has been contaminated for some time are presented, and connections are established between the global contamination of a locality with $^{95}Zr + ^{95}Nb$ and the precipitation, as well as between the global contamination and the character of the underlying surface. High sensitivity and high productivity is claimed for the method, since it becomes possible to cover several thousand of linear kilometers with one airplane in one working day. For $^{95}Zr + ^{95}Nb$ the minimum recorded amounts of radioactivity are several mCi/km^2, corresponding to ~0.1 microrad/hr at an altitude of 1 meter. (ATD)

18972 REPORT ON THE ATMOSPHERIC RADIOACTIVITY IN THE CSSR IN 1966. Petrovic, Pavel. Meteorol. Zpr., 20: 157-64(Dec. 1967). (In Czech).

The measurement made on the radioactivity of the air and the results of the monthly, weekly, and daily fallout in 1966 were reported. A meteorological analysis was made of the extrema of the atmospheric radioactivity. The air radioactivity in Bratislava obtained by continuous and discontinuous measurements was compared. (tr-auth)

18973 ENVIRONMENTAL RADIOACTIVITY AND ENVIRONMENTAL MONITORING OF NUCLEAR INSTALLATIONS. Vogt, Kurt-Juergen (Zentralabteilung Strahlenschutz der Kernforschungsanlage, Juelich, Ger.). Z. Tech. Ueberwach., 7: 17-24 (1966). (In German).

Before the construction of a nuclear installation the radioactive background from natural radioactivity and artificial radioisotopes produced by nuclear weapons should be determined. The radioactive emission released with the waste air and the waste water of the nuclear installation must be discriminated from the background. The origin, magnitude, and propagation of the various contributions to the environmental radioactivity and the consequent dangers to man in the normal operation and the event of an accident of special reactor types are discussed and the modification of the environment is considered. The problems, monitoring methods, and measuring methods of the environmental monitoring system of the Julich nuclear installation are described in some detail. (tr-auth)

18974 MEASUREMENTS OF ALPHA ACTIVITY IN "THICK" TEST LAYERS FOR MONITORING THE ENVIRONMENT. Haberer, K. (Chemischen Laboratorien der Stadtuerke, Wiesbaden). Atompraxis, 13: 443-4(Oct. 1967). (In German).

A nomogram was designed for rapid energy and matrix correction of alpha-activity measurements in thick-saturation layers. The advantages of this method for samples with low alpha activity, such as occur in environmental monitoring, are described. (auth)

18975 MEASUREMENTS OF RADIOACTIVITY AT DIFFERENT ALTITUDES IN THE ATMOSPHERE DURING ARRIVAL AND PASSAGE OF FRESH FISSION PRODUCTS. Fischer, H.-F.; Paffrath, D.; Peters, W. (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt e. V., Munich). Atompraxis, 13: 444-7(Oct. 1967). (In German).

After the third Chinese nuclear weapon test, measuring flights in the atmosphere at altitudes up to 12,500 M were performed for collecting aerosols on fiber filters. The method of sampling is described. The fraction of fresh debris to total amount of debris is determined by β-disintegration curves of the samples. Vertical profiles of the specific β-activity of the air for old and fresh fission products are represented by graphs. These results are compared with measurements after the first and second Chinese nuclear test. In addition to fission products of the nuclear explosion neutron induced nuclides ^{237}U and ^{239}Np were identified by means of gamma-ray spectrometry. (auth)

18976 RAINOUT CHARACTERISTICS FOR HYDROLOGICAL STUDIES. Stout, G. E.; Huff, F. A. (Illinois State Water Survey, Urbana). pp 61-72 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

During a 4-yr period extensive areal and time sampling was performed of the radioactivity in rainwater in central United States of America. Many surface observations and some airborne water collections were made. It is evident from the data that great variations in raincut are likely during convective storm periods and that those engaged in atmospheric tracer studies must exercise extreme care in the interpretation of observational data because of the natural variability in such storms. Analyses of spatial variability showed a trend for the relative

variability of radioactive rainout to: exceed the storm rainfall variability; decrease with increasing rainfall volume and storm duration; and increase with increasing network size. Point representativeness indicating an average error of 20 to 25% is introduced when a single observation is assumed to represent the mean rainout over areas of 10 to 12 square miles. The rainout on May 26, 1965, after the Chinese bomb test is used to illustrate the distribution of rainout in time and space over a small network of five recording air- and water-sampling sites in an area of 36 square miles. Airborne observations are also discussed. A classification of the types of time distributions of rainout is proposed, based upon a large sample of observational data. (auth)

18977 INTERPRETATION OF INITIAL RIOMETRIC OBSERVATIONS ON WAKE ISLAND DURING THE HIGH-ALTITUDE EXPLOSION OF JULY 9, 1962. Kozlov, S. I. Kosm. Issled., 5: 782-91(1967). (In Russian).

The experimental data obtained on Wake Island during the 1962 high altitude thermonuclear absorption over Johnston Island are analyzed. The purpose of the analysis is to explain the sudden 2db increase in 20 to 50 MHz radio wave absorption, 3 sec after the explosion. The ionizing effect of 2- and 14-MeV neutrons on the atmosphere up to 100 km is analyzed first. This ionization mechanism is then discarded. Instead, it is shown that 0.143 keV x rays and fission product γ rays generate enough electrons to cause a 2-db absorption at 30 MHz frequency. Electron densities are obtained as a function of altitude for various time intervals, x-ray energies, and γ fluxes. The analysis is assumed to be approximate because of lack of reliable information on ion recombination and dissociative electron recombination coefficients. (ATD)

Mineralogy and Exploration

Refer also to abstracts 18895, 18945, and 19143.

18978 (BM-RI-6932) CHATTANOOGA SHALE INVESTIGATIONS. Hickman, Robert C.; Lynch, V. J. (Bureau of Mines, Knoxville, Tenn.). Aug. 1966. 55p. Bureau of Mines.

Preliminary evidence indicated that the Chattanooga Shale might constitute a potential vast low-grade source of uranium. Investigation by core drilling indicated that while the Chattanooga Shale may constitute a resource for the future, the very low (0.006 percent) average uranium content is not economic when compared with the relatively higher grade western ores. A total of approximately 12,000 feet of test drilling was done in 72 drillholes, and large samples were mined for extractive and metallurgical testing. An experimental mine site was selected on the basis of the drilling project. (auth)

18979 URANIUM CONTENT IN CASSITERITES DETERMINED BY URANIUM FISSION FRAGMENT TRACKS. Berzina, I. G.; Dolomanova, E. I. Dokl. Akad. Nauk SSSR, 175: 171-4 (July 1, 1967). (In Russian).

Thin sections of cassiterites were exposed to an integral thermal neutron dose of 8.4×10^{15} n/cm^2 to detect low concentrations of uranium in these minerals. The fission product tracks were developed by treating the detector with an aqueous solution of 40% potassium hydroxide at 60°C. The recording efficiency of the tracks was assumed to be 76%. It was found that the tracks were unevenly distributed, reflecting the uneven fission of uranium in the growth regions of cassiterites. Only a few micromineral inclusions were noted in white cassiterites with thin yellowish bands by the electron-microscopic study of the tracks. In the black and dark brown specimens, the microminerals were concentrated in thick aggregations forming radial tracks. The background uranium concentration in the light minerals range from 1.2 to 1.3×10^{-6} g/g; in the dark-colored ones it ranged from 2.0 to 3.6×10^{-6} g/g. The presence of uranium probably affects the coloration of the mineral. (TTT)

18980 STATUS REPORT FROM AUSTRALIA. Stewart, J. R. (Australian Atomic Energy Commission, Coogee). pp 3-8 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967.

See STI/PUB-146.

During the period 1954 to 1959, five plants for the production of uranium chemical concentrates (yellowcake) were constructed in Australia. Only one of these is in operation, but two more have been kept on a "care-and-maintenance" basis pending revival of the market for uranium. The other two were disbanded after completion of contract production. Brief details of each of the plants are given. (auth)

18981 STATUS REPORT FROM CANADA. Thunaes, A. (Eldorado Mining and Refining, Ltd., Ottawa). pp 9-14 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967.

See STI/PUB-146.

Canadian facilities and methods for processing uranium ores are described. Improvements that have been made in the processing methods are outlined, and development work towards further improvements is indicated. (L.C.L.)

18982 STATUS REPORT FROM CZECHOSLOVAKIA. Civin, V.; Belsky, M. (Research and Development Lab. No. 3 of the Uranium Industry, Prague). pp 15-18 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967.

See STI/PUB-146.

Methods used for processing low-grade uranium ores in Czechoslovakia are described. The problems encountered with these methods and the solution to the problems are outlined. (L.C.L.)

18983 STATUS REPORT FROM FRANCE. Sugier, P. (CEA, Chatillon-sur-Bagneux, France). pp 18-27 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967. (In French).

See STI/PUB-146.

Methods used for processing low-grade uranium ores at three plants in France are described. (L.C.L.)

18984 STATUS REPORT FROM INDIA. Fareeduddin, S. (Atomic Energy Establishment Trombay, Bombay). pp 27-31 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967.

See STI/PUB-146.

Uranium sources in India are described, and methods used for processing these ores discussed. (L.C.L.)

18985 STATUS REPORT FROM PORTUGAL. Carreira Pich, H. (Junta de Energia Nuclear, Sacavem, Portugal). pp 31-3 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967. (In French).

See STI/PUB-146.

The treatment of a phosphate ore of Angola with a uranium content of about 0.05% U_3O_8 was described. The classical leaching procedure using sulfuric acid and extraction by phosphoric esters was used without difficulty. However, the economy of the recovery of uranium from these ores depends entirely on the possibility of recovery of phosphoric acid. (tr-auth)

18986 STATUS REPORT FROM SOUTH AFRICA. Robinson, R. E. (Atomic Energy Board, Pretoria). pp 33-7 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967.

See STI/PUB-146.

Uranium ore processing methods used in South Africa and research of new methods are described. (L.C.L.)

18987 STATUS REPORT FROM SPAIN. Josa, J. M. (Junta de Energia Nuclear, Madrid). pp 37-41 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967. (In Spanish).

See STI/PUB-146.

Spain is interested in the evaluation of its radioactive reserves, and for that reason is carrying out an extensive geological prospection program. Techniques for the treatment of the minerals found, primarily by conventional methods, are being developed. The continued operation of ore processing plants and the construction of larger installations is planned. (J.S.R.)

18988 STATUS REPORT FROM SWEDEN. Peterson, A. (Aktiebolaget Atomenergi, Stockholm). pp 41-8 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967.

See STI/PUB-146.

A brief but comprehensive summary of uranium production in Sweden is given, including details on the location and composition of uranium ores, mining methods, the separation processes used, the treatment of process wastes, and the costs of uranium processing. (L.C.L.)

18989 STATUS REPORT FOR THE USSR. Zefirov, A. P. (State Committee on Utilization of Atomic Energy, Moscow). pp 49-58 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967. (In Russian).

See STI/PUB-146.

Soviet studies and developments with respect to the enrichment of low-grade uranium ores, hydrometallurgical processing of ores,

extraction recovery of uranium, and control and regulation of technological processes are reported. (J.S.R.)

18990 STATUS REPORT FROM THE UNITED KINGDOM. North, A. A. (Warren Spring Lab., Stevenage, Eng.). pp 58-61 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967.
See STI/PUB-146.
Methods used in the United Kingdom for processing low-grade uranium ores from foreign sources are described. (L.C.L.)

18991 STATUS REPORT FROM THE UNITED STATES OF AMERICA. Kennedy, R. H. (Atomic Energy Commission, Washington, D. C.). pp 61-3 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967.
See STI/PUB-146.
The leaching and recovery methods used in the USA for processing uranium ores are discussed. (L.C.L.)

18992 STATUS REPORT FROM YUGOSLAVIA. Bunji, B. (Inst. for Tech. of Nuclear and other Raw Materials, Belgrade). pp 63-4 of Processing of Low-Grade Uranium Ores. Vienna, International Atomic Energy Agency, 1967.
See STI/PUB-146.
Yugoslavian experience in the processing of low-grade uranium ores by alkaline leaching and by hydrogen pressure reduction methods is summarized. (L.C.L.)

18993 CARBONATITES. Tuttle, O. F.; Gittins, J. (eds.). New York, Interscience Publishers, 1966. 609p. $22.50.
Field and laboratory studies of carbonatites and their associated rocks are described. Detailed descriptions of the principal varieties of carbonatite complexes and laboratory investigations regarding the problems of carbonatite genesis are presented. A bibliography of carbonatite occurrences throughout the world is included. (R.C.K.)

Oceanography

Refer also to abstracts 19059–19062.

18994 (A/AC.82/G/L-1168) SODERZHANIE STRONTSIYA-90 I TSEZIYA-137 V VODAKH ATLANTICHESKOGO OKEANA I EGO MOREI V APRELE-IYULE 1964 G. (Concentration of ^{90}Sr and ^{137}Cs in the Waters of the Atlantic Ocean and its Seas in April–June 1964). Gedeonov, L. I.; Dmitriev, V. N.; Ivanova, L. M.; Maksimova, A. M.; Nelepo, B. A.; Stepanov, A. V.; Fleishman, D. G.; Yakovleva, G. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1967. 31p. (In Russian). Dep.
The results of the investigation of the content of ^{90}Sr and ^{137}Cs in waters of the Atlantic Ocean and its seas, carried out in 1964 were presented. For determination of ^{90}Sr and ^{137}Cs, the methods of their joint concentration from one sample of sea water were used. The results of the analysis of 70 samples of sea and ocean waters, of which 28 were deep samples, were given. The changes of the mean concentration of ^{90}Sr in surface waters in northern and tropic zones of the Atlantic from 1961 to 1964 were reported. Data on the mean concentration of ^{137}Cs in three zones of the Atlantic were obtained first. Changes of the mean concentration of ^{90}Sr followed from changes of the mean annual fallout from the atmosphere. Waters of different levels down to depths of 2000 m were tested for their content of ^{90}Sr and ^{137}Cs. In 1964 the concentration of ^{90}Sr and ^{137}Cs at each level was higher than in 1963. In 1964 the reserve of ^{90}Sr at the 1000 m level was 55 $\mu c/km^2$ and that of ^{137}Cs was 100 $\mu c/km^2$. The ratio of the concentration of ^{137}Cs to ^{90}Sr, determined for waters of the Atlantic Ocean, was 1.7. (tr-auth)

18995 (NYO-3109-26) STUDIES OF OCEANOGRAPHIC FACTORS AFFECTING THE USE OF NUCLEAR POWER SOURCES IN OR ADJACENT TO THE SEA. Progress Report, July 1, 1966–September 30, 1967. (Johns Hopkins Univ., Baltimore, Md. Chesapeake Bay Inst.). Contract AT(30-1)-3109. 9p. Dep. CFSTI.
Progress is reported on empirical and theoretical studies of the physical processes of movement and diffusion of radioactive materials in marine environments; methods for the prediction of the probable distribution concentration of radioactivity from existing and proposed radioactive sources in the oceans; and the distribution of excess temperature from heated discharges into coastal and estuarine waters. (R.C.K.)

18996 CONTRIBUTION TO THE KINETIC THEORY OF BED-MATERIAL DISCHARGE. Todorovic, P.; Vukmirovic, V.; Vukotic, R. (Jaroslav Cerni Inst. for the Development of Water Resources, Yugoslavia). pp 271-90 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.
From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.
The investigations of fundamental kinetic characteristics of bed-material discharge can be carried out by means of radioactive tracers. Comprehensive studies on bed-load features using radioactive tracers are described. These experiments have been accomplished on the Danube and Velika Morava Rivers. A theoretical base to the study of the kinetic characteristics of bed-material discharge is given, and the practical application of the results obtained discussed. Theoretically, the problem of bed-material discharge moving was considered from the standard point of the stochastic process. With regard to the specificity of the nature of the considered phenomenon, a new stochastic process $X_t = \pi(t,\omega)$ of non-decreasing sample functions was introduced. An effort was made to obtain some information on the one-dimensional distribution function $F(x|t)$ of the considered process. This was achieved by means of approximations $F_1(x|t)$ and $F_2(x|t)$ of $F(x|t)$, where $0 \leq F_1 \leq F \leq F_2 \leq 1$. This indicates the probability that the projection of a particle to moment t, would not exceed the point x. These approximations represent the solution of the problem. An important point must be emphasized concerning the use of theoretical results; the theory concerns the movements of a single particle of bed-material discharge. Owing to practical applications, all particles must have identical transport characteristics. If we consider the particles with different dimensions, they have different transport characteristics. The solution of this problem is also presented. The obtained theoretical results can be applied to experimental ones on the assumption that a straight uniform alluvial channel, in which the water flow is stationary, be considered instead of a river bed. Some experiments are presented, as well as the technique of estimating parameters characterizing the moving of bed-material discharge, by means of which the corresponding functions F_1 and F_2 are specified. (auth)

Seismology

Refer also to abstracts 19000 and 19001.

18997 DIAGNOSING UNDERGROUND EXPLOSIONS AND EARTHQUAKES. Thirlaway, H. I. S. Contemp. Phys., 9: 17-31(Jan. 1968).
Although the amplitude of the signal itself is an inverse function of distance, it is easier to discriminate between an underground explosion and an earthquake at a great distance from the source than closer at hand. Two types of elastic waves are used—the longitudinal P-waves (detected by a seismometer of about 1 sec period) and the surface Rayleigh R-waves (detected by a 20 sec seismometer). An account is given of the principles of short-period array systems and their diagnostic performance, and of the independent diagnosis afforded by observations of the R-waves. The relevance of the experimental facilities and of the analytical results to more general geophysical and geological problems is briefly mentioned. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstract 18977.

18998 (LA-3864) STABILITY OF THE NEW RADIO FLASH CODE. Richtmyer, R. D. (Los Alamos Scientific Lab., N. Mex.). Aug. 1967. Contract W-7405-eng-36. 15p. Dep. CFSTI.

An analysis was made of the Radio Flash Code for calculating the radio emission from underground and atmospheric explosions. (M.O.W.)

18999 (PNE-1003) GASBUGGY PRELIMINARY POSTSHOT SUMMARY REPORT. Holzer, Fred (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 1968. Contract W-7405-eng-48. 19p. (UCRL-50386). Dep. CFSTI.

The Project Gasbuggy nuclear explosion of nominally 26-kt yield was detonated on Sunday, December 10, 1967. Indications are that the explosive performed satisfactorily. Preliminary information is available on subsurface and surface ground motions, on the extent of the fractures, on the gas pressure in the chimney, and on the concentration of radionuclides. Subsurface ground velocities measured in instrument hole GB-D located 1470 ft from the emplacement hole range from about 1.15 to 1.6 m/sec depending on the gage location. These values are somewhat but not surprisingly higher than expected. Peak surface velocities range from 1.6 m/sec at the surface above the explosion to about 0.4 m/sec 8400 ft away. Both these data as well as preliminary values of ground motion out to a range of 60 miles are in very good agreement with preshot expectations. No damage was sustained by any of the conventional gas wells which were as close as 2600 ft to the explosion, and no structural damage has been reported from the surrounding area. Reentry drilling through the 7-in. casing on which the explosive canister was lowered established connection with the chimney at a depth of 3907 ft below the ground surface. A gas pressure of 833 psi was measured at the surface, and some xenon-133 activity was detected in samples. No other radioactive nuclide has been detected in the gas, although gas samples taken at depth have not as yet been analyzed. Density, gamma-radiation, and caliper logs indicate that a number of breaks or offsets have occurred ranging from 3805 ft down to the void at 3907 ft. These locations are in good agreement with data from fracture instrumentation in GB-1, correlate with preshot rock weaknesses, and compare favorably with predictions. Data from preliminary short term flow tests are not conclusive, and cannot be considered significant relative to either reservoir evaluation or chimney volume determination. Future work should shed light on the connection of the reentry hole with the chimney and on the nature of the chimney itself. (auth)

19000 (UCID-15283) STRESS HISTORY MEASUREMENTS: HARDHAT EVENT. Heusinkveld, M.; Holzer, F.; Marks, R.; Harris, D. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 1962. Revised Feb. 1968. Contract W-7405-eng-48. 14p. Dep. CFSTI.

The Hardhat Event was detonated on February 15, 1962, at the Nevada Test Site. The nuclear device was placed at a depth of 950 feet in a granite medium. The dynamic stress in the rock was measured by means of transducers located at approximately this depth and at distances of 200, 350, and 700 ft from the point of detonation. The stress curves were plotted and compared with theoretical predictions. (L.C.L.)

19001 (UCRL-50373) CALCULATION OF FREE-FIELD MOTION FOR THE PILEDRIVER EVENT. Cherry, J. T.; Rapp, E. G. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 2, 1968. Contract W-7405-eng-48. 9p. Dep. CFSTI.

The results of a technique which seems to calculate adequately the free-field motion resulting from a contained explosive event in granite is presented. The calculation indicates that free-field motion from Piledriver was no greater than might have been expected. The significance of the extent of compressive cracking to chimney formation has been discussed. Finally, it is shown qualitatively that the returning tensile wave can have a significant effect on late-stage cavity growth. This, we feel, is the reason for the "larger-than-expected" cavity radius observed in the Piledriver Event. (auth)

19002 MANHATTAN PROJECT. The Untold Story of the Making of the Atomic Bomb. Groueff, Stephane. Boston, Little, Brown and Co., 1967. 381p. $6.95.

Manhattan Project is an account of the events which led to the production of the first atomic bomb between 1942 and 1945. The scope of the venture and the amassment of scientists, engineers, industrialists, and military leaders who forged the new technology are discussed. (R.C.K.)

Facilities and Equipment

Refer also to abstracts 18980, 18981, 19033, 19052, 19055, 19338, 19577, 19899, 19902, 19910, 19920, 20381, 20984, 20991, 21002, 21003, 21005, and 21006.

19003 (COO-1248-10) METHODS OF GENERATING MONODISPERSE AEROSOLS. Liu, Benjamin Y. H. (Minnesota Univ., Minneapolis. Particle Technology Lab.). Feb. 1967. Contract AT(11-1)-1248. 34p. (CONF-670204-2). Dep. CFSTI.

From 84th Conference on Methods in Air Pollution and Industrial Hygiene Studies, Oakland, Calif.

The principal characteristics of each of the three monodisperse aerosol generators are described. Although there exists no universal aerosol generator suitable for all applications, the great majority of the needs for a monodisperse aerosol probably can be met by one or more of the three generators described. (auth)

19004 (EURAEC-1943) PRESTRESSED CONCRETE CAISSON FOR A 1000 MWe BOILING WATER REACTOR, VARIANT: CAISSON WITH METAL COVER. Final Report. (Societe d'Etudes et d'Equipments d'Entreprises, Paris (France)). Oct. 1967. Contract 068-65-7-TEEF. 115p. (EUR-3762). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The adaptation of the prestressed concrete caisson technique to the boiling water reactor string is described. In the course of the adaptation survey, a reference design was defined for a monolithic prestressed concrete caisson. Further research consisted of examining the possibility of replacing it with a caisson closed by a detachable metal cover, so that the whole of the recess is left free. This variant cuts the diameter of the caisson (for equal power) and permits a return to a method of plant operation similar to procedure in current BWRs using a metal caisson. The new caisson was examined from the feasibility, reference design, and economic standpoints. The comparison shows that the solution involving a caisson with metal cover is more economical than the monolithic caisson solution, and should therefore be developed further. (auth)

19005 (TID-4100(Suppl.41)) SUPPLEMENTAL INSERT SHEETS FOR ENGINEERING MATERIALS LIST. Kelly, Robert C. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Oct. 1967. 48p. DTIE Free.

Thirty-two packages of engineering materials on accelerator computer, and electronic equipment; an F_2 cleanup reactor; materials testing equipment, radiation detectors; and samplers are announced in this supplement for inclusion in TID-4100. (F.S.)

19006 (TID-4100(Suppl.43)) SUPPLEMENTAL INSERT SHEETS FOR ENGINEERING MATERIALS LIST. Kelly, Robert C. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Feb. 1968. 51p. DTIE Free.

Twenty-seven packages of engineering materials on accelerators; chemical equipment, including dryers, evaporators, polarographs, and titrators; equipment used in the conversion of UN to UO_2; facilities for reactor irradiation, magnet testing, and UF_6 sampling and storage; radiation detectors; shielded containers; and a zonal centrifuge are announced for inclusion in TID-4100. (F.S.)

19007 (ORNL-tr-1877) BASIC RESEARCH ON DESIGN AND PRACTICE RELATED TO PRESTRESSED CONCRETE PRESSURE VESSELS. (PART 2). Fujita, Kametaro. Translated for Oak Ridge National Lab., Tenn., from Konkurito Jaaaru, 5: No. 10, 25-34(1967). 20p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

Prestressed concrete is finding increased use as a material for nuclear power reactor pressure vessels. Therefore, an investigation of the characteristics of prestressed concrete pressure vessels was conducted. Studies were made of the behavior of the material at high temperature, the stress in prestressed concrete cylinders subjected to temperature gradients, photoelastic stress determinations with epoxy resin models, and the development of a circumferential prestressing method using stranded steel wires wrapped around adjustable flat jacks on the exterior of the pres-

sure vessel. A linear relationship for the creep coefficient of prestressed concrete in terms of temperature was obtained. The elasticity theory was found to be useful for simplifying the determination of thermal stresses from temperature gradients, and resulted in higher-than-actual stresses. The 3-dimensional photoelastic tests were effective for determination of stress distributions in complex-shaped pressure vessels. The flat jack technique was demonstrated experimentally to be a method for applying very accurately controlled circumferential prestresses to very large annular structures with savings in the amount of steel required, no internal friction in the concrete, and other advantages. (L.C.L.)

19008 CONSTRUCTION PROBLEMS OF INDUSTRIAL RADIATION LOOPS. Kiknadze, G. I.; Gambaryan, V. G.; Zaharov, D. M. At. Energ. (USSR), 23: 553-5(Dec. 1967). (In Russian).

Comparison of operational experiences with radiation loops and isotopic radiation sources using long lived isotopes, such as ^{60}Co for carrying out large-scale industrial radiation-chemical processes, indicates that the former are more efficient. Using the data published at the Second Geneva Conference, the relative energy released in radiation loops, the power level of the sources was tabulated, assuming that operation of the ^{60}Co source is limited to one half-life. Nuclear power stations are of special interest for industrial application of radiation loops. The study indicated that power reactors with a lower power level than that of the Novo-Voronezh power plant, with a more complex core at higher thermal neutron flux density at its boundary might be more economical. The best γ radiation carrier in loops in an indium-gallium alloy; no sufficient data are yet available concerning the proposed indium-gallium-tin system. Selection of the material should not be based simply on the eutectic composition of the alloy. (TTT)

19009 TELEMANIPULATORS IN THE NUCLEAR DOMAIN. Grenon, Michel. Sci. Progr.-Nature, No. 3392, 459-63(Dec. 1967). (In French).

Telemanipulators can be divided into two classes: master-slave devices and remote control devices. Examples are given of each of these types of devices, and the uses and limitations of each are indicated. (J.S.R.)

19010 MACHINE WELDING OF FUEL AND CONTROL RODS FOR NUCLEAR REACTORS. Droscha, H. Atompraxis, 14: 28-30(Jan. 1968). (In German).

In the machine installation described, nuclear reactor fuel cans or control rods are welded to their sealing plugs electrically under inert gas after nuclear fuel or neutron absorbent material has been introduced. This takes place in a hermetically sealed chamber by means of the arc from a nonfusible tungsten electrode, the torch remaining stationary and the work-piece rotating. Only circumferential welds are made. The workpiece is secured by two clamping rings; it is introduced horizontally into the cylindrical charging chamber and pushed through its opening into the welding chamber until its front end comes up against a stop. The rotary motion necessary for welding is imparted to the rod resting on bearings in the charging chamber by means of an electric motor drive via an infinitely variable mechanical gear. During the welding process, the charging and welding chambers together form an enclosure filled with inert gas. However, when changing workpieces they are separated so that the charging chamber can act as a lock and only its inert gas content requires to be renewed. (auth)

19011 CREEP DEFORMATION OF THICK PRESTRESSED RINGS. Miller, Charles A. (IIT Research Inst., Chicago). Nucl. Eng. Design, 7: 87-93(1968).

The creep response of a thick, circular, prestressed ring subjected to internal pressure is considered in this paper. Prestress is assumed to be applied by an elastic wire (or band) wound around the outside diameter of the ring. The viscoelastic behavior of the ring material is represented by an elastic unit in series with a Kelvin unit. Poisson's ratio is assumed to be a constant during creep. Laplace transforms are taken of the thick ring, equilibrium and stress strain equations; and solution is then carried out with the transformed variables. The inverse transformations can be taken in closed form and expressions are thereby derived for the variations with time of: prestress, stress distribution, and deformation. It is found that the stress variation across the ring remains constant but decreases in magnitude with increasing time. The prestress level may decrease by significant amounts. This solution has direct application to the analysis of the response of prestressed concrete vessels. Such vessels are being considered for reactor pressure vessels. (auth)

19012 AIRBORNE PRECIPITATION COLLECTOR. Bradley, Wayne E.; Martin, Gordon E. (Illinois State Water Survey, Urbana). Contract AT(11-1)-1199. J. Appl. Meteorol., 6: 717-23(Aug. 1967). (COO-1199-11).

A high-volume airborne precipitation collector is described. The device, installed in the nose of a twin-engine aircraft, has a 30-cm diameter intake that extends ahead of the aircraft nose. Both air and rain enter the collector where the liquid water is separated from the air by impaction and centrifugal force. Measurements of the airflow in the collector are described and the resulting collection efficiency for precipitation-size droplets is calculated and discussed. The device is being used to determine if radioactive particles are washed from the air by precipitation between cloud base and the surface by comparing the activities of surface and airborne samples. The implications of one set of samples are summarized. (auth)

19013 LOW TEMPERATURE IRRADIATION. Electron. Ind. (Paris), No. 103, 461(May 1967). (In French).

A system generating radiation at temperatures approaching 20°K was installed in the "Triton" reactor at Fontenay-aux-Roses. It includes a cryostat with liquid N_2 maintaining fluid connected to a Philips cryogenerator running on a Stirling cycle putting out 300 W at 76°K from the first stage and 100 W at 20°K from the second. These two parts are supported on a moving carriage set up around the reactor perimeter enabling the transient irradiation flux on the bottom of the cryostat to be varied very fast. Physical measurements (electrical resistivity, tensile stress, and elongation) can be made both with and without flux, at the irradiation temperature. To take laboratory measurements, however, means are provided to extract the cryostat samples without allowing them to rise in temperature. For short exposures (a few hours) it is likewise possible to pour liquid He into the cryostat, should irradiation at a temperature of about 4.2°K be desired. (Sum. Art. Tr. Tech. Press)

19014 INFANT SUPPORTER AND IMMOBILIZER FOR RADIOGRAPHY. Chartres, J. C. (Pembroke County War Memorial Hospital, Haverfordwest, Wales). Radiography, 33: 119-23(June 1967).

A device for holding infants during x-ray photography which allows reduced radiation exposure of patient and personnel, is described and illustrated. This apparatus is designed to handle small infants, including premature babies, from the age of 1 day to 12 months. For radiographic exposures, an increase in 3 to 4 kVP on normal exposure for the part was found adequate to compensate for use of the immobilizer. There is no irradiation of the staff as there is no holding of the baby. The radiation dose to the infant is reduced because accurate coning of the primary beam is more easily done, and there is reduced number of repeat exposures due to faulty positioning or to rotation of chest, or to masking of film by chin and limbs. The apparatus is adaptable to almost any make of vertical cassette stand. The apparatus is safe, and radiolucent foam blocks tend to comfort as well as support the infant. Crying and struggling are therefore reduced and better chest films result. There are no extraneous shadows on films for chest and skull and minimal x ray scatter combined by using molded plywood instead of plastic. The apparatus is now available commercially. (BBB)

19015 TINY THERMOCOUPLES: ADVANCES IN DESIGN EXTEND APPLICATIONS. Sannes, T. (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Instrum. Technol., 14: 35-40(Mar. 1967).

Characteristics and applications of tiny thermocouples are discussed. The properties of mineral-insulated thermocouples include small diameter, long length, mechanical flexibility, fast response time, shock resistance (mechanical and thermal), radiation resistance, and shielding (electrical, mechanical and chemical). The use of thermocouples in the fields of nuclear power, automobile tests, steel and concrete, heavy machinery, and plastics, textiles and ceramics is discussed. (IAA)

19016 VII INTERNATIONAL MINERAL PROCESSING CONGRESS. Technical Papers Presented September 20–24, 1964. Volume 1. Arbiter, Nathaniel (ed.). New York, Gordon and Breach Science Publishers, Inc., 1965. 611p. (CONF-640933-Vol.1).

Mineral processes reported are comminution, gravity and dense media separation, chemical processing, flotation kinetics and practices, the chemistry of flotation, surface chemistry in mineral processing, magnetic and electrical separation, and automation and control. A total of 55 papers was presented. Separate abstracts were prepared for two of these. (J.C.W.)

For abstracts of individual sections see: 19017 and 19018.

19017 SOME EXAMPLES OF THE USE OF CONTROL AND REGULATION IN URANIUM ORE DRESSING AND HYDROMETALLURGY. Vuchot, L. (S.E.R.I., Billancourt, France); Bavoux, B.; Gabillat, L.; Zegers, J. C. pp 493-501 of VII Inter-

national Mineral Processing Congress. Arbiter, Nathaniel (ed.). New York, Gordon and Breach Science Publishers, Inc., 1965.
From 7th International Mineral Processing Congress, Columbia, N. Y. See CONF-640933-Vol.1.

Details of instrumentation and control at the Forez, France, feed preparation plant, the La Crouzille preconcentration plant and the leaching plant of the Compagnie des Mines D'Uranium in Gabon are reported. The Forez plant which involves crushing and rod-milling uses continuous measurement of pulp density, pulp flow rate, uranium content and weight, with pulp density automatically controlled. The La Crouzille grading plant rejects low grade uranium ore by continuously measuring weight and radioactivity on a fixed length of conveyor. The combination of signals either actuates or fails to actuate a shunting switch for discarding ore before the cut-off grade. The Gabon leaching plant controls involve measuring, indicating and servo devices for flow rate, pH, redox potential, temperature and acid titer. Future developments as well as the costs and savings already effected are discussed. (auth)

19018 CONVERSION TO ORE-PEBBLE GRINDING. Roach, A. G.; Anderson, A. C.; Ehrlich, R. P. (Rio Algom Mines Ltd., Ontario, Can.). pp 505-14 of VII International Mineral Processing Congress. Arbiter, Nathaniel (ed.). New York, Gordon and Breach Science Publishers, Inc., 1965.
From 7th International Mineral Processing Congress, Columbia, N. Y. See CONF-640933-Vol.1.

The change from ball mill grinding to ore-pebble grinding in the uranium mills of the Rio Tinto Group in Elliot Lake is described. These mills, with a capacity of 3,000 tons each, originally handled minus 0.75 inch feed through rod and ball mills prior to leaching with sulfuric acid. The mechanics of the changeover are described, together with some of the difficulties encountered. Current grinding practice is covered. (auth)

19019 DEVICE FOR TAKING OUT MOLD GOODS. Ogawa, Ichijuro (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-3589. Mar. 2, 1967. Filed Dec. 11, 1962.

Removing nuclear fuel from its container, done usually by hand, is very dangerous. By the device proposed, the handling can be done by a mechanical means. It includes the molding machine; the base, located at some distance from the machine, which has a slide mechanism engaged with the drive of the machine; the slide sub-base, which slides on the base driven by the mechanism; the slide plate, installed on to the slide sub-base, which contacts to the upper surface of the molding machine when the sub-base approaches closest to the machine, and along which a picked up molding is moved; the wheel mechanisms at both ends of the slide sub-base; and the plate, which has a protrusion with a hook for the molding. By this mechanism, a molding can be picked up from the molding machine, moved horizontally and dropped at a suitable position near the wheel mechanism (opposed to that near the machine). And the slide sub-base can then be returned to its original position. (NSA of Japan)

19020 FILTER DEVICE USED IN THE PATH OF A FLUID CONTAINING RADIOACTIVE(OR OTHER) MATERIAL. Murakami, Masatoshi (to Japan Atomic Energy Research Inst.). Japanese Patent 1967-6119. Mar. 11, 1967. Filed Apr. 23, 1962.

A method is proposed for replacing used filters, by which trapped dust can be prevented from escaping and radioactive dust can be adequately shielded. Before removing a used filter from the path, the filter with trapped dust is sprayed with a liquid, which fixes the dust in the filter by a device installed in the fluid path. If it is radioactive, a shielding powder, in addition to the fixing liquid, is sprayed onto the filter by a device installed in the path. (NSA of Japan)

19021 TRANSFER SYSTEM FOR A HOT CELL. Andre, Roger; Fradin, Jean; Renard, Michel (to Commissariat a l'Energie Atomique). British Patent 1,105,078. Mar. 6, 1968. Priority date Feb. 25, 1966, France.

A transfer system is described which is used to transfer samples between a hot cell and a conveying vessel without interrupting the shielding or leakproofing of the hot cell operation. The system consists of a lock formed through the cell wall, a biological shielding attachment carried by the cell but situated outside the cell and a movable unit consisting of a carriage which moves between the interior of the cell and the biological shielding attachment. (F.S.)

19022 IMPROVEMENTS IN OR RELATING TO STEAM GENERATORS. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,105,588. Mar. 6, 1968. Priority date Nov. 26, 1964, Germany.

A steam generator is described consisting of a mixing vessel, the lower portion of which is enveloped by an eccentric housing connected to a superheated steam pipe. The wall of the mixing vessel has the inlet superheated steam apertures leading in tangentially. The superheated steam is used in evaporating the condensate in the generator. The generator is useful in steam-cooled reactors. (F.S.)

19023 GLOVE BOXES (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1690).
25 drawings

A modular-type glove box is described which may be fabricated to enclose either a 22 or 45 ft^3 volume. The box is used to control contamination from toxic metals, for controlled atmospheres, or contamination. (For details see TID-4100 Suppl. 44). (F.S.)

19024 VAPOR PRESSURE CALORIMETER (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). (CAPE-1685).
45 drawings.

Modifications of a Giauque-Johnston cryostat are described. The modified cryostat or calorimeter is used for thermal measurements in the temperature range of 2 to 300°K. Efficient low temperature heat switches are used for independently cooling the sample container and the surrounding shield. The sample container is fabricated from 99.999% Cu to achieve high thermal conductivity. The variable temperature copper regulated shield between the cold wall and the inner sections of the cryostat leads to a working section which can be maintained to a millidegree at any temperature in the working range of the cryostat. The thermostated shield is maintained about 2°K colder than the sample vessel when the temperature is above 70°K. (For details see TID-4100 Suppl. 44) (F.S.)

19025 DEVICE FOR INTRODUCING RADIOACTIVE PELLETS INTO A TUBULAR RECEPTACLE. Andre, Roger; Fradin, Jean; Gaudichard, Claude (to Commissariat a l'Energie Atomique). British Patent 1,103,870. Feb. 21, 1968. Priority date Feb. 2, 1966, France.

The design of remote handling equipment for loading radioactive pellets into a tube is given. (J.C.W.)

19026 DEVICE FOR ELECTRICALLY INDICATING THE POSITION OF A REMOTE MECHANISM. Taylor, James Russell; Lewis, John Peter Leonard (to Strachan and Henshaw Ltd.). British Patent 1,103,887. Feb. 21, 1968. Filed Nov. 26, 1965.

The design of an electric device which indicates the position of a remote mechanism is presented. A solenoid remotely operates a mechanism actuated from a direct current source through a pair of electrical conductors. (J.C.W.)

19027 DEVICE FOR EFFECTING THE ACCURATE POSITIONAL ADJUSTMENT OF A COMPONENT. Thireau, Remy (to Commissariat a l'Energie Atomique). British Patent 1,103,677. Feb. 21, 1968. Priority date Dec. 3, 1965, France.

The design of an apparatus for effecting the accurate positioning of a component is given. A movable control rod with 2 screw-threads of different pitch, a motor which controls the displacement of the rod and the rotating shaft attached to the rod, and a guide complex on the motor comprise the device. (J.C.W.)

19028 MACHINE TOOL FOR MACHINING CHEVRON-PATTERN GROOVES INSIDE TUBULAR ELEMENTS. (to Commissariat a l'Energie Atomique). British Patent 1,103,848. Feb. 21, 1968. Priority date Oct. 9, 1965, France.

A machine designed to produce tubular fuel elements for reactors having sets of fins on the inner surface for increased heat-exchange surface is described. The tubular elements have inner sections separated by longitudinal grooves machined so as to present helical chevron-pattern grooves with opposite helical pitch in two adjacent sections. (J.C.W.)

19029 IMPROVEMENTS IN METHODS OF SHAPING METALS UNDER HIGH HYDROSTATIC PRESSURE. Sauve, Charles (to Commissariat a l'Energie Atomique). British Patent 1,103,749. Feb. 21, 1968. Priority date Oct. 25, 1965, France.

The process for the shaping of metals under high hydrostatic pressure has been improved. The process consists in transmitting an extrusion pressure to the metal by means of a first Newtonian liquid which is stable at the working temperature and in receiving the metal as it passes out of the first die within a receiving container filled with a second Newtonian liquid also stable at working temperatures. (J.C.W.)

19030 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. (to United Kingdom Atomic Energy Authority). British Patent 1,104,631. Feb. 28, 1968. Filed Dec. 16, 1963.

The design of a nuclear fuel element assembly is given. The fuel

rods are parallel longitudinally. Spacers are placed between adjacent fuel elements and the specifications for the support structure of the spacers are summarized. The spacer rings have an external surface of a partial sphere to accommodate the longitudinal thermal expansion of the fuel rods. (J.C.W.)

Heat Transfer and Fluid Flow

Refer also to abstracts 19509, 20815, 20833, and 21003.

19031 (AERE-R-5145) HARWELL HIGH PRESSURE HEAT TRANSFER LOOP. Bennett, A. W.; Keeys, R. K. F. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1967. 45p. Dep. CFSTI. UK 8s. 0d.

A description is presented of the Harwell high pressure, steam-water heat transfer loop. The operating instructions for the loop are included. (auth)

19032 (BNWL-616) HOTANK: A STEADY-STATE HEAT TRANSFER PROGRAM FOR USE ON THE UNIVAC 1107/1108. Willingham, W. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1968. Contract AT(45-1)-1830. 38p. Dep. CFSTI.

A computer program is presented for the calculation of steady-state temperatures in heat and nonheat-generating systems suitable for a two-dimensional system of cylindrical geometry. The program is capable of handling problems with constant or temperature dependent thermal conductivities, internal heat generation, and constant film or contact coefficients. No attempt has been made to include radiation effects within the program. The results are calculated by an iterative process using the nodal or lumped parameter method of analysis. (auth)

19033 (LA-3881) SPACE ELECTRIC POWER R AND D PROGRAM. Quarterly Status Report for the Period Ending January 31, 1968. Part I. (Los Alamos Scientific Lab., N. Mex.). Feb. 21, 1968. Contract W-7405-eng-36. 7p. Dep. CFSTI.

Experiments which are being conducted to determine the effect of many variables on the performance of heat pipes are described. These variables include the heat pipe design, the materials used, vapor flow conditions, vibration, type of heat pipe fluid, and the wick design and material. (L.C.L.)

19034 (TID-24285) EXPERIMENTAL INVESTIGATION OF THE SETTLING OF PARTICLES IN LAMINAR FLOW IN HORIZONTAL TUBING. Wojan, Clifford A.; Buono, Dennis F.; Reichman, James M. (Polytechnic Inst. of Brooklyn, N. Y. Dept. of Mechanical Engineering). Jan. 15, 1968. Contract AT(30-1)-3871. 36p. Dep. CFSTI.

The settling rate of aerosol particles from a gas in streamline flow in long, straight, horizontal tubes is dependent upon such factors as particle size, volume flow rate, gravitational force, tube length and tube diameter. A change in one of these factors leads to a predictable change in the amount of particles that precipitate from, or settle out of the air flow. It appears that elbows or bends in the tubing affect the amount of particles precipitated. Equations used to predict precipitation rates in straight tubes do not seem satisfactory for tubes containing many bends. (auth)

19035 (UCRL-70827) SELF-GENERATING BRAYTON CYCLE PERFORMANCE MODEL. Richter, Horst P. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 15, 1967. Contract W-7405-eng-48. 44p. (CONF-680306-1). Dep. CFSTI.

From 13th Annual International Gas Turbine Conference and Products Show, Washington, D. C.

A mathematical model is described which permits the performance analysis of advanced Brayton cycles as used in turbine engines for stationary and flight power plant applications. The model permits the performance evaluation of different working fluids, provides for various component combinations, and facilitates exchange of parameters and variables for off-design point performance and trade-off studies. The concept of entropy production is used for expressing the losses (irreversible effects, efficiencies) occurring in components of turbine engines. The derived equations permit the use of specific heat as a function of temperature in energy, entropy, and mass flow relations and establish a consistent set which facilitates the generalized performance analysis. Examples related to open and closed Brayton cycles are discussed. Two significant relationships are obtained for the evaluation of working fluids. (auth)

19036 (AD-660432) USE OF LIQUID-METAL MELTS IN DIFFERENT BRANCHES OF INDUSTRY. Chaevskii, M. I. Translated from Nauch. Zab. Inst. Mashinoved. Avtomat. Akad. Nauk Ukr. SSR, Ser. Mashinoved., 9: No. 8, 11-21(1962). 14p. (FTD-MT-67-82). JCL $1.60 fs, $0.80 mf.

The use of low-melting metal melts as operational media is illustrated by a number of examples in the field of thermal power engineering; foundry and heat treatment of metals; machine and instrument building and the glass industry. Except for a heat supply system in a Soviet metallurgical combine, using mercury or a sodium and potassium melt as heat carriers, all the models or systems presented are of American or British origin. They include: heat treatment and bright annealing furnaces; a system for cooling the valve of an internal combustion engine; a high-sensitivity mercury bearing; electromagnetic pumps for the transportation of liquid metals, and the production of high-quality plate glass with the use of a molten metal bath. It is concluded that the wide use of liquid-metal melts as heat carriers will be only possible, when the problem concerning the operational capacity of materials being in contact with the melts has been solved. (ATD)

19037 (NASA-TT-F-431) HEAT AND MASS TRANSFER. VOLUME I. CONVECTIVE HEAT EXCHANGE IN A HOMOGENEOUS MEDIUM. Translation of Teplo- i Massoperenos. Konvektivnyi Teploobmen v Odnorodnoi Srede, Nauka i Tekhnika, Minsk, USSR, 1965. 274p. (TT-67-51367; IPST-Cat.-1842). CFSTI.

Heat transfer and friction resistance of fluids under conditions of substantial changes in their physical properties as a function of the temperature, with special emphasis on their flow in pipes are reported. Heat transfer and resistance in systems of various geometrical shapes of pipes and channels are summarized. Connective heat transfer under unsteady-state conditions, hydrodynamics and heat transfer in jets, and intensification of convective heat transfer processes are reported. Thirty-six reports are included. (J.C.W.)

19038 ANALOG SOLUTION FOR THE TRANSIENT HEAT DIFFUSION PROBLEM IN A REACTOR FUEL ELEMENT. Elmeshad, Y. (Atomic Energy Establishment, Cairo); Feretic, D.; Elashmawi, F. Atomkernenergie, 13: 105-10(1968).

The theory of using an electrolytic tank analog to get a step by step solution of diffusion equations at fixed time, is extended to cases of multiregion problems with different external and interface boundary conditions. The radial temperature field in a cylindrical fuel element with a relatively thick cladding is determined analytically (neglecting the cladding curvature). The analog results for a model of this fuel element compares well with the presented analytical solution. The transient temperature distribution in a finned fuel element is then determined by the analog method. The work demonstrates the feasibility of using electrolytic tank models to get the transient cross-sectional two-dimensional temperature distribution in such reactor fuel elements. (auth)

19039 CONVECTIVE HEAT TRANSFER THROUGH LIQUID METALS. Coombs, J. S. (University Coll., Swansea, Eng.); Gibbon, W. M.; Probert, S. D. Chem. Process Eng., 49: 96-102(Mar. 1968).

Liquid metals are finding increasing application as convective heat transfer media for nuclear reactors and other high-temperature plants. Satisfactory design of such equipment depends on a comprehensive knowledge of the heat transfer characteristics of these metals through pipes, tube bundles, etc. The work carried out so far in this field, and the conclusions reached are discussed. (auth)

19040 MIXING OF A TRACE GAS IN FLOWING HELIUM. Carroll, R. M.; Perez, R. B.; Sisman, O. (Oak Ridge National Lab., Tenn.). Nucl. Appl., 4: 268-76(Apr. 1968).

For in-pile sweep-gas experiments it is sometimes necessary to deduce the time-dependent release rate of a radioactive gas from a specimen by measurements made at some point downstream. An experimental method is described to measure the amount of dispersion of the radioactive gas in the sweep gas. By this method correction factors can be applied to a measured wave shape to obtain the generated wave shape. A theoretical model, assuming axial turbulent flow of the sweep gas with a flat radial distribution, has been developed. Application of the model involves an experimentally determined parameter "a" for the particular sweep-gas system used. The agreement between the experiment and the theoretical model is excellent. (auth)

19041 EXPLANATION OF EXPERIMENTAL DATA BY THE CRITICAL HEAT FLUX IN FLUID FLOW IN TUBES. Ivashkevich, A. A. Teploenergetika, No. 10, 68-71(Oct. 1967). (In Russian).

A system of parameters, determining the critical point of the bubble boiling point, was used to explain the data on the critical thermal flux during forced motion in the tubes and circular channels of underheated liquids and steam–liquid mixtures. (tr-auth)

19042 KINETICS OF NON-ISOTHERMAL NON-CATALYTIC HETEROGENEOUS REACTIONS: THE HYDROFLUORINATION OF POROUS SPHERES OF URANIUM DIOXIDE. Costa, Eduardo Calmon. Davis, Calif., Univ. of California, 1967. 390p. Thesis.

The hydrofluorination kinetics of porous spheres of a nonstoichiometric uranium dioxide (O/U = 2.14) have been studied. Pellets of 2 cm diameter, with 0.715 total porosity, were hydrofluorinated at temperatures ranging from the kinetic to the diffusion regimes (30 to 367°C). Reaction rates were obtained from weight change measurements, and temperatures at the surface and center of the pellets were recorded continuously during reaction. An Arrhenius plot of the initial reaction rates, correlated with temperatures and concentrations at the reaction surface, gave an activation energy of 6.07 kcal/g-mole. At low temperatures there is absorption of HF in addition to reaction. This gives high apparent reaction rates, and causes the low-temperature end of the Arrhenius plot to curve. Heat transfer coefficients at the external surface of the pellet, and effective thermal conductivities and effective diffusivities in the porous product layer, were obtained from the experimental data under reaction conditions. These data combined with calculated mass transfer coefficients were used in the prediction of conversion- and temperature-time curves under conditions approaching an unreacted-core model. Both a pseudo-steady and an unsteady state approach for heat transfer were used in these calculations. The pseudo-steady state approach gave good agreement with the experimental conversion and temperature data when conditions approached an isothermal unreacted core. The unsteady state approach, however, was better suited for conditions approaching a non-isothermal unreacted core. Results also indicate the need for a careful evaluation of the effective diffusivity when applying these prediction methods to untried situations. The effects of cracking, plugging of pores, and sintering of the product layer must be taken into account. (Disser. Abstr.)

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Refer also to abstracts 18704, 18925, 18929–18940, 18995, 19008, 19178, 20928, and 20929.

19043 (DP-1143-1) SAVANNAH RIVER LABORATORY ISOTOPIC POWER AND HEAT SOURCES. PART I. ^{60}Co. Quarterly Progress Report, October–December 1967. Hilborn, H. S. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan. 1968. Contract AT(07-2)-1. 12p. Dep. CFSTI.

Operation of capsules for ^{60}Co at 1000°C for one year will not be limited by diffusion of ^{60}Co in Hastelloy X, Hastelloy C, or Haynes 25, but may be limited by diffusion in Inconel 600 and TD Nickel. Several encapsulating alloys showed acceptable oxidation resistance at 1000°C in air for 9400 hr. Inconel 600 and Hastelloy X capsules that were heated in air at 1000°C for 5000 hr had no measurable dimension changes or leaks and predictably small oxidation and reaction layers. The capsules had 0.050-inch-thick walls and contained inactive cobalt wafers. A 0.050-inch-wall Inconel 600 capsule containing 15,000 curies of ^{60}Co as 150-curie/gram wafers had no measurable dimension changes or leaks after 5000 hr in air at ~850°C. Destructive examination is in progress. (auth)

19044 (MLM-1437) RADIOISOJET MICROTHRUSTER TEST: A SUMMARY REPORT. Johnson, E. W.; Glaub, J. E. (Mound Lab., Miamisburg, Ohio). Apr. 21, 1967. Contract AT(33-1)-Gen-53. 22p. Dep. CFSTI.

The promethium-147 radioisojet microthruster was tested during November, 1966. Two series of tests of the electrically heated microthruster were also performed, one test series before installation of the promethium-147 radioactive source. Constant temperature measurement tests and temperature recovery tests were performed with the promethium-147 capsule as the heat source. Core temperatures reached a maximum in excess of 1500°F. (auth)

19045 (MMM-3691-26) SNAP-21 PROGRAM, PHASE II. DEEP SEA RADIOISOTOPE-FUELED THERMOELECTRIC GENERATOR POWER SUPPLY SYSTEM. Quarterly Report No. 6, October 1, 1967–December 31, 1967. Fox, F. (Minnesota Mining and Mfg. Co., St. Paul). Feb. 1968. Contract AT(30-1)-3691. 178p. Dep. CFSTI.

SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-21) — power supply system for, design and testing of
FUEL CAPSULES — design, fabrication, and testing of SNAP-21
SHIELDING — design of biological, for SNAP-21
THERMAL INSULATION — development and fabrication of SNAP-21
HEAT TRANSFER — analysis of SNAP-21 system
THERMOELECTRIC CELLS — components for SNAP-21, design and testing of
SYSTEM FOR NUCLEAR AUXILIARY POWER (SNAP-21) — thermoelectric generator for, shock and vibration testing of
THERMOCOUPLES — development and testing of, for SNAP-21 thermoelectric generator
PRESSURE VESSELS — design and testing of SNAP-21
HEAT SOURCES — development and testing of SNAP-21
ALUMINUM OXIDES — use of plasma sprayed, for SNAP-21 compatibility barrier material
SHIPPING — container for SNAP-21, dynamic testing of
(R.C.K.)

19046 (N-67-23959) INVESTIGATION OF THE USE OF A RADIOISOTOPE FOR SPACE ENVIRONMENT SIMULATION. Final Report. Newell, D. M. (Philco-Ford Corp., Palo Alto, Calif. Space and Re-Entry Systems Div.). Mar. 19, 1967. Contract NAS2-3506. 83p. (NASA-CR-73082; SRS-TR-150). CFSTI.

The incorporation of a beta-emitting radioisotope in an environmental simulation chamber which already included control of the parametric variables of vacuum (gaseous environment), sample temperature, and solar electromagnetic radiation is discussed. The theoretical and analytical bases for selection and design of a sealed strontium 90-yttrium 91-titanate source, spectral calibration of the resultant source, electron dosimetry determinations at the sample sites within the chamber, operating experiences, prototype specimen exposure test results, and system evaluation are described. The resulting electron spectrum was measured; it includes electrons in the 35 keV to 2.0 MeV range, which compares favorably with the electron spectra for 800, 1500, and 18,000 nautical mile equatorial orbits. Flux levels similar to real space environment were achieved. Solar radiation covering the spectral range from 0.2 to 1.4 microns was provided simultaneously with the electron irradiation. Samples of thermal control materials were irradiated in the combined environment for 765.5 hr without interruption. (STAR)

19047 (ORNL-IIC-13) LIST OF AEC RADIOISOTOPE CUSTOMERS WITH SUMMARY OF RADIOISOTOPE SHIPMENTS, FY 1967. Curl, Ruth (comp.) (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 40p. Dep. CFSTI.

An alphabetical list is given of customers with the isotopes identified which each purchased during 1967 from the Atomic Energy Commission suppliers. Cross references are included of customers, location, and summaries of geographical concentrations of isotope users. A table including a listing of isotopes delineated into shipments, quantities, and dollars for each isotope is presented. (J.C.W.)

19048 (STI/PUB-141) ISOTOPES IN HYDROLOGY. Proceedings Series. Proceedings of the Symposium held in Vienna, 14–18 November 1966. (International Atomic Energy Agency, Vienna (Austria)). 1967. 740p. (In several languages). (CONF-661133). IAEA: $15.00; Austrian Schillings 388,–; £ 5.5.10; F Fr 73,50; DM 60,–.

Forty-one papers on the use of radioisotopes in hydrology are presented. Separate abstracts were prepared for each. (L.C.L.)

For abstracts of individual papers see: 18924–18942, 18976, 18996, 19057–19075, and 19178.

19049 (MLM-1467(tr)) SHAPE FACTORS AFFECTING THERMAL DIFFUSION IN THE EXP-6 BUCKINGHAM MODEL. Saviron, J. M.; Gonzalez, D.; Madariaga, J. A. Translated for Mound Lab., Miamisburg, Ohio, from An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 61: 361-2(1966). 6p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The effects of shape factors, which define the molecular interaction of the gas, on thermal diffusion in Clusius–Dickel columns are considered. The shape factors for the Exp-6 Buckingham potential were calculated and tabulated. (M.C.G.)

19050 REVIEW OF ISOTOPIC METHODS USED IN THE INVESTIGATION OF FLUIDAL LAYERS IN THE OIL INDUSTRY. Zablotny, Wladyslaw (Inst. of Nuclear Research, Warsaw). Przem. Chem., 47: 7-9(Jan. 1968). (In Polish).

A brief review is given of the isotope tracer method used in prospecting, drilling, and surveying of oil bearing deposits. (R.V.J.)

19051 CURRENT SOURCES SUPPLIED BY RADIONUCLIDES. Makra, Zsigmond Fiz. Szemle, 18: 16-21(1968). (In Hungarian).

Current sources fed by the decay heat of radionuclides are widely used for applications requiring a relatively low rate of consumption for long periods of time, during which no refueling or maintenance operations may be carried out. The current may be generated directly by collecting the emitted α or β particles, or indirectly, by making use of the heat generated when the emitted particles are slowed down by the moderator. The heat to electrical energy conversion may be accomplished by means of thermionic diodes or by the thermocouples Generators developed in the United States and the Soviet Union are based on the second approach. The radionuclides used must have a sufficiently long half-life, and high specific heat generation rate; they must be available in large amounts at a reasonable price. Radiation protection problems must also be taken into account when designing the source. At present, ^{90}Sr, ^{137}Cs, ^{60}Co, ^{147}Pm, ^{144}Ce, ^{238}Pu, ^{244}Cm, ^{242}Cm, and ^{210}Po are used most widely. Characteristics of various SNAP and Soviet sources are listed. (TTT)

19052 SENSITIVE RADIOTRACER TECHNIQUE FOR MEASURING ABRASIVITY OF MAGNETIC RECORDING TAPES. Buchanan, John D.; Tuttle, John D. (Isotopes, Inc., Palo Alto, Calif.). Int. J. Appl. Radiat. Isotop., 19: 101-21(Feb. 1968).

A special magnetic tape transport system and radioactive dummy recorder heads were designed and constructed to provide a sensitive, rapid, and precise method of measuring the abrasivity of magnetic recording tapes under conditions closely approximating their use in actual instrumentation recorders. The tape contact face of the dummy-recorder head was made of neutron-activated Kovar. Two-hundred-foot samples of 0.5-in. wide instrumentation tape were tested using the same tape wrap angles, tensions, and speeds as those used in actual recorders. The amount of radioactivity transferred to the tape was used to establish the amount of Kovar worn from the head. The precision of 5-pass tests was about 4%. Virtually all of the abraded radioactive material adhered to the tape. Abrasivity was directly proportional to tape tension, but independent of tape speed. Relatively large differences in abrasivity were found, even among samples from the same reel of tape. Comparison of measurements made with radioactive heads of two different designs indicates that the test method gives relative abrasivity values applicable to actual recorder heads. (auth)

19053 USE OF RADIOISOTOPES AND NUCLEAR PHYSICS METHODS AND INSTRUMENTS IN METALLURGY AND METAL STUDIES. Gruzin, P. L.; Babikova, Yu. F. Zavod. Lab., 33: 1260-72(1967). (In Russian).

Individual studies on the use of radioisotopes and nuclear physics methods and instruments in the area of metal physics and metallurgy were reviewed. The results showed that the use of these methods and techniques make it possible to solve a series of scientific and practical problems of primary importance in metallurgy and metal studies. 83 references. (J.S.R.)

19054 DESIGN AND VEHICLE INTEGRATION OF A ^{238}Pu BRAYTON POWER SYSTEM FOR MORL. Kirkland, Vern D.; McKhann, George G. (Douglas Aircraft Co., Huntington Beach, Calif.). J. Spacecraft Rockets, 5: 241-6(Mar. 1968).

The early studies of the NASA Manned Orbital Research Laboratory (MORL) concept led to the conclusion that a solar-cell/battery power system should be selected because of its proven technology. However, the Pu-238 Brayton power system appeared to be a preferable alternative because of such operational advantages as freedom of vehicle orientation and minimum interference with extravehicular activity and with experiments and equipment located outside the laboratory. Accordingly, a detailed study of the design of an 11.0-kW(e) Pu-238 radioisotope Brayton-cycle power system and of the integration of the system into the MORL vehicle was undertaken. The results include a system description and performance specification, and the conclusion that the system is attractive for the MORL application and is superior to other isotope power systems. (auth)

19055 TRACER STUDY OF THE WORKING FLUID REFLUX IN DIFFUSION PUMPS. Fleischer, W.; Winkler, K.; Birkigt, W.; Schneider, K.-H. Isotopenpraxis, 3: 403-5(1967). (In German).

Labelling oils with ^{82}Br enables the reliable and rapid detection of oil contamination caused by the reflux of the working fluid into diffusion pumps. (auth)

19056 INDUSTRIAL APPLICATIONS OF IONIZING RADIATIONS. Jefferson, S.; Roberts, R.; Ley, F. J.; Rogers, F. (Atomic Energy Research Establishment, Wantage, Eng.). Advan. Nucl. Sci. Technol., 4: 335-83(1968).

The use of x rays, gamma rays, and high-energy electrons in the chemical, medical product, and food industries is discussed. The uses of ionizing radiations in the chemical industry for graft polymerization, curing of paints, preparation of wood-plastic combinations, synthesis of ethyl bromide, production of alkane sulfonates, and vulcanization of rubber are described. The uses of ionizing radiations in the medical product and food industries for the sterilization of medical supplies and food products are discussed. Sources of ionizing radiation are described. (R.C.K.)

19057 APPLICATION OF RADIOTRACER METHODS IN STREAMFLOW MEASUREMENTS. Dincer, T. (International Atomic Energy Agency, Vienna). pp 93-113 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

An attempt was made to evaluate methods using radiotracers in streamflow measurements. The basic principles of the tracer method are explained and background information given. Radiotracers used in stream discharge measurements are discussed and measurements made by different research workers are described. Problems such as adsorption of the tracer and the mixing length are discussed and the potential use of the radioisotopes as tracer in the routine stream-gauging work is evaluated. It is concluded that, at the present stage of development, radiotracer methods do not seem to be ready for routine use in stream-gauging work, and can only be used in some special cases. For gamma-emitting radioisotopes there are problems related to safety, transport and injection which should be solved. Tritium, though a very attractive tracer in some respects, has the disadvantages of having a relatively long half-life and of disturbing the natural tritium levels in the region. Finally, an attempt was made to define the objectives of the research in the field of application of radioisotopes in hydrometry. (auth)

19058 RADIOISOTOPES IN SEDIMENTOLOGY. Courtois, G. (CEA, Saclay, France). pp 117-65 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967. (In French).

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

Radioisotopes have two main uses in sedimentology: for the study of sediment movements in rivers and seas, and for continuous measurements of the amount of sediment suspended in a given medium. These uses are considered in detail, and brief accounts given of some other uses. After describing the basic technique used in sediment movement tracer studies, the problems that can be solved with the help of this technique are described. Essentially, these are: problems related to civil engineering works in coastal areas: the siltation of harbor channels and docks, the formation of banks and bars, the choice of sites for disposing of dredged sediment, the siting of ports, coastline protection, etc., problems associated with civil engineering works in and near rivers, siting of the water intakes of hydroelectric and nuclear power stations, the effects of construction work on the transport of solids, the construction of dams, the protection of river banks, the construction of jetties, the siltation of lakes, etc., problems common to these include the transport of effluent and the calibration of hydraulic models; and problems related to basic or applied research conducted mainly by universities and research centers such as the study of the Quaternary of a particular region, pure sedimentology, the investigation of major sediment transport currents, the confirmation or refutation of transport theories, research into fundamental transport phenomena associated with channel experiments. After referring to the possible exploitation of natural tracers (contained in radioactive waste and fallout), the technical aspects of using artificial tracers including the choice of radioisotope, surface and mass labelling (with particular reference to the problem of silting), immersion and detection equipment, and problems of navigation and topographical reference points are discussed. The problem of obtaining quantitative results is discussed and the proposed methods described. Current, highly commendable attempts to relate the numerous sediment transport theories to measurements carried out in situ with radioactive tracers are mentioned. The methods described may also be applied to related problems of considerable importance (soil erosion, soil stabilization and the movement of sand dunes) and brief references are made to these problems. Finally, the current possibilities of using radioisotopes in sedimentology, their limitations and the improvement which should be made in their application are reviewed. (auth)

19059 RADIOISOTOPE TECHNIQUES FOR DETERMINING SILT MOVEMENT FROM SPOIL GROUNDS IN THE FIRTH OF FORTH. Smith, D. B.; Parsons, T. V. (Atomic Energy Research Establishment, Wantage, Eng.). pp 167-80 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

The techniques used in a series of investigations into silt movement from spoil grounds in the Forth estuary are described. The tracers used were ^{46}Sc and ^{140}La, incorporated in ground glass which was distributed in spoil in a hopper and deposited to simulate normal dredging practice. Qualitative tracer movement was measured in the estuary and quantitative values were obtained in a dockyard by measurement of the vertical distribution of the tracer. The extensive upstream movement of spoil from the normal area of deposition showed that it was an economically unsatisfactory spoil ground. An alternative area was selected by study of the topography of the estuary bed and the prediction of downstream silt movement from this area was confirmed by tracer studies. (auth)

19060 QUANTITATIVE MEASUREMENT OF MARITIME SEDIMENT MOVEMENT USING RADIOACTIVE TRACERS. Makovski, E.; Grissener, G. pp 181-90 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967. (In Russian).

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

The quantitative method described involves burying appropriate detectors over a given area of the sea bottom, the detectors being connected to recording equipment which is itself buried in the sediment or situated on the shore. Detectors arranged in this way are covered by a layer of radioactive sediment whose activity is proportional to its mass. Before the labelled sediments are removed, their initial activity is measured, and then, as the covering is removed, measurements are made of the gradual decrease in activity corresponding to loss of the surface layer of the bottom deposit area under investigation, expressed in g/cm^2. The tracers used in the investigations discussed were natural ones such as sea with ^{31}Si and artificial ones such as activated fragments of sodium glass (with a 6.5% admixture of Fe_2O_3) with ^{24}Na. The proportional dependence of activity on mass has been confirmed for both tracers; this is an essential point for a tracer intended for quantitative measurements. This proportionality is very well maintained if a sample of highly active sediment is introduced into a large mass of inactive sediments (10^{-2} to 10^{-3}). The advantages of this method as a possible way of using radioisotopes with a short half-life and a low total activity of the order of a few millicuries are described. (auth)

19061 RADIOISOTOPE TECHNIQUES DEVELOPED IN WATER-POLLUTION STUDIES. Eden, G. E.; Briggs, R. (Water Pollution Research Lab., Stevenage, Eng.). pp 191-206 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

During the last 10 yr radioisotopes have been used in many aspects of water pollution research to provide information which could not have been otherwise obtained. Though these techniques have been applied to the study of sewage treatment and disposal rather than to hydrology as normally understood, they could well find application in purely hydrological fields. Instrumentation for tracing dispersal of sewage in the sea is discussed. The tracer ^{82}Br is added continuously to the flow of sewage entering the sea through a submerged outfall, or alternatively as a single dose to the sea at the site of a hypothetical outfall. The dispersal is mapped by scanning the area with γ-scintillation counters towed by a catamaran at predetermined depths, the depths being continuously monitored by simple echo sounders. The counting rates, after scaling by a factor of 10, are recorded as pulses on individual tracks of a multichannel tape-recorder, other tracks being used as a verbal notebook and for timing pulses. The tapes are subsequently replayed on shore, the recorded information being transferred to conventional chart recorders or to scalers. Results of typical surveys will be given. Double-labelling techniques are described. By use of a non-adsorbable tracer (for example ^{82}Br, or ^{60}Co or ^{58}Co) to label the liquid phase and a highly adsorbed tracer (for example ^{198}Au or ^{110m}Ag) to label the solid phase, it is possible to study segregation effects. The technique was used to demonstrate the short-circuiting of solids in a sludge-digestion system and to compare relative retention periods of dissolved and suspended matter in a percolating filter. By simultaneous addition of a non-adsorbed tracer and the radioisotope under investigation it is possible to detect reversible adsorption on the bed of a stream or on the walls of a sewer. Measurements of the ratio of the activities due to the two tracers at a point downstream provides an extremely sensitive method of detecting reversible adsorption; this procedure might well be of use in selecting tracers for the determination of flow in streams by tracer methods. (auth)

19062 SURFACE LABELLING OF SAND WITH ^{51}Cr BY THERMAL DECOMPOSITION OF AMMONIUM DICHROMATE ^{51}Cr. Campbell, B. L.; Seatonberry, B. W. (Australian Atomic Energy Commission, Sutherland, New South Wales). pp 227-32 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

A new and efficient method for labelling sand with multicurie amounts of ^{51}Cr is described. It is based on the formation of chromic oxide when ammonium dichromate is thermally decomposed. The technique has been used successfully with silica sand from Botany Bay, N. S. W. The ammonium dichromate is intimately mixed with the sand and then decomposed by raising the temperature while keeping the mass stirred. About 70% of the chromic oxide adheres to the sand. The radioactive label is stable over long periods of immersion in sea water and is resistant to the type of abrasion which can occur in sand-tracing experiments. The application of this method to the production of 25-kg batches of labelled sand is described. It is possible that the method could be applied to other granular solids which are stable up to 400°C. (auth)

19063 SURFACE DEPOSITION OF RADIOISOTOPES ON SANDS AND SILTS. Bougault, H.; Caillot, A.; Courtois, G.; Jeanneau, B. (CEA, Saclay, France). pp 233-62 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967. (In French).

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

There are two major methods of using radioisotopes to study sedimentary movements: mass-labelling—the sediment is replaced by a glass containing an element that can be activated; surface labelling—a physico-chemical treatment makes it possible to deposit a radioisotope on the surface of the sediment. The second method is used mainly for sands, when a large number of labelled particles is necessary (for statistical purposes); and for silts, when it is necessary to retain the features associated with their dynamic properties. Simple and rapid methods of labelling were developed which could be applied at the site of the experiment by persons possessing only limited equipment for handling radioisotopes. The process recommended for labelling sands by using ^{198}Au is a combination of the Petersen method (treatment with tin chloride) and that of Campbell (treatment with silver) after pre-treatment with nitric acid and soda. By this method, it is possible to deposit 125 mg of gold per kilogram of sediment with an efficiency of 95% (i.e. 10 Ci/kg) using a solution of chlorauric acid. For marking sands with ^{51}Cr a film of silica gel is first deposited and radioactive lead chromate is then adsorbed on to it. In this way, 500 mg of chromium per kilogram of sand can be fixed with more than 90% efficiency (i.e., 40 Ci/kg). The mechanical stability of the deposits, their value and their reproducibility for a given mineral composition of the sand are discussed. The labelling of silts by using ^{198}Au is achieved with a neutralized chlorauric acid solution. The gold is reduced on contact with the silt on which it is fixed. Ten Ci/kg of sediment can be fixed with 100% efficiency. To mark silts with ^{51}Cr chromium hydroxide is precipitated on contact with the silt. This results in a deposit of 450 mg of chromium per kilogram of sediment, i.e., 25 Ci/kg of silt, with 100% efficiency. The validity of the labelling, its effect on the dynamic behavior of the silt and the number of particles labelled are discussed. As quantitative movement studies necessitate mass-labelling (constant specific activity), the transformation required to make surface labelling tantamount to mass-labelling is indicated. The future prospects and the approaches to be used in this work are presented. (auth)

19064 INVESTIGATION INTO THE MOVEMENT OF FLUVIAL BED-LOAD WITH RADIOISOTOPES. Erdelyszky, Zs.; Stelczer, K. (Research Inst. for Water Resources Development, Budapest). pp 263-9 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

A new method was devised for determining the abrasion of sediment grains under natural conditions. An attempt was made to follow sediment grains of different diameter and of known weight, then to lift them from the bed after a certain time, once they had travelled along a definite route. To carry out this method similarly marked gravels of different spectrum energy corresponding to different diameters were put into the water at a certain point in the Danube after which they were followed with a special nuclear device prepared for this purpose, so that the grains of the sediment could be separated according to their diameters. With the help of a five-channel amplitude analyzer the radiations of different wavelength can be registered separately, so that the route taken by the gravels of different diameter can be determined. The route taken by the sediment was followed with a small boat which had a 10-m arm on which a five-scintillation receiver was located. Thus, it

was possible to make measurements up to a depth of 6 to 7 m. After commencing the experiments, it was possible in 1965 to extract the first grains from a stretch of the Danube that has intensive sedimentation which, within 27 days travelled 384 m. Following this 13 more marked grains were taken from the Danube. The wear on the extracted grains was determined and the results compared with the data from our investigations and with that from the more widely known data in literature. (auth)

19065 EROSION BY RAIN IN THE WESTERN CONGO. de Ploey, J. (Univ., Louvain, Belg.). pp 291-301 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967. (In French).

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

Vast expanses of the western part of central and southern Africa are covered with uniform, sandy formations of the Kalahari type. The topography of these areas and their present morphological characteristics are mainly the result of erosion by rain. Information on the hydrology of the surface waters in these areas is fairly limited and is insufficient to permit any conclusions regarding the way in which erosion by rain takes place. To obtain a better understanding of these phenomena, a series of experiments based on the use of ^{46}Sc-labelled radioactive sand were devised. These experiments began at the beginning of the 1964/65 rainy season and are continuing. The experimental plot corresponds to convex and rectilinear portions of a hillside with a slope varying between 0 and 12°. The vegetation consists of grassy savannah of sub-steppe appearance and secondary forests. Series of labelled samples were placed successively on the surface of the experimental plot and the erosive effect of rain was determined by measuring the residual concentrations after rainfall. Some samples were placed below a shield so as to eliminate the effects of splash and reveal the part played by run-off. Radiographic films were used to study the dispersion of labelled particles in the surrounding area. This radiographic method made it possible to determine the scale of erosion by splash for different rainfall conditions. The erosion diagrams obtained from these experiments show the correlations that exist between the intensity and duration of the rainfall and the erosion of the soil. Examination of the erosion diagrams and the shielded samples and analysis of the radiographs showed that erosion by rain on Kalahari ground covered with sub-steppe savannah is caused mainly by splash erosion and by dispersed, intermittent run-off. Sheet-wash plays no part if the slope is less than 12°. (auth)

19066 APPLICATION OF RADIATION LOGS TO GROUNDWATER HYDROLOGY. Keys, W. Scott (Geological Survey, Denver). pp 477-88 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

The drilling of exploratory holes to determine the availability of groundwater and to plan the most economical methods of water development is expensive. The only technique available at present for obtaining geological and hydrological information through the casing of pre-existing water wells and other boreholes is by radiation logging. Up to now these logging techniques have been little used in groundwater hydrology. Inexpensive portable radiation logging equipment is described that is available or has been developed for groundwater studies in connection with a general research project on the application of borehole geophysics in groundwater hydrology. It is possible to obtain data on the following: the source, velocity, and chemical quality of groundwater; the location, extent, geometry, bulk density, porosity, permeability, and specific yield of aquifers and associated strata; and the position of casings, casing collars, leaks, perforations, and cement. The radiation logs employed include natural gamma, gamma-gamma, neutron-gamma, neutron epithermal-neutron, and radioactive tracer. The following radioisotopes are utilized: cobalt-60, plutonium-239, americium-241, and iodine-131. Typical radiation logs obtained by the various techniques are described and examples are given of practical applications of radiation logging to groundwater investigations. The applications cited are studies of perched water in basaltic rocks and associated sedimentary strata; the porosity, moisture content, and position of zones into which water was injected in volcanic tuff; the position of the interface between brine and fresh water in fine-grained carbonate rocks and associated fine clastic rocks; the interpretation of porosity from a neutron log; and the location by means of a radioactive tracer of the more permeable fracture zones in a well penetrating crystalline rock. (auth)

19067 RADIOISOTOPE TRACERS IN LARGE-SCALE RECHARGE STUDIES OF GROUNDWATER. Sternau, R. (Water Planning for Israel Ltd., Tel Aviv); Schwarz, J.; Mercado, A.; Harpaz, Y.; Nir, A.; Halevy, E. pp 489-505 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

Dynamic investigations of large-scale groundwater recharge and mixing require a reliable tracing method. In the absence of natural tracer in the recharged water, tagging of a few million cubic meters with $K_3{}^{60}Co(CN)_6$ afforded excellent tracing possibilities. The tracer was injected into the aquifers at a maximum concentration of 2×10^{-6} Ci/m^3. The hydrological basis, isotope production, injection, pumping, sampling procedures, and evaluation of results are described. For measurements of the pumped water in the field, a special gamma-detection system (W-11), having a sensitivity of 3×10^{-7} Ci/m^3 for 10 standard deviations, was designed. Small samples from observation boreholes were taken to the laboratory for measurements in another specially designed system (SELRON). It is shown that routine large-scale hydrological engineering applications of radiotracers are beneficial and feasible. Owing to the sensitivity and stability of the monitoring system, the concentration of tracer at input was 0.02 of MPC. This ensured public protection without any sacrifice of precision. (auth)

19068 SINGLE-WELL PULSE TECHNIQUE. Borowczyk, M. (Geological Inst., Warsaw); Mairhofer, J.; Zuber, A. pp 507-19 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

Some theoretical and experimental problems of the single-well pulse technique proposed in Israel are described. The single-well technique is based on a traced injection, pause and pumping. Knowing the thickness of an aquifer as well as the pumping rate, it is possible to find a distance travelled by a tracer during the pause from the measurement of tracer concentration in pumped water. The ratio of distance and duration of the pause gives natural groundwater velocity. The problem may sometimes be solved for a two-layered aquifer. A new method for interpreting the arrival time of the tracer is proposed. It is based on the time of 50% recovery of recovered amount of an injected tracer. This method seems to be essential when very high dispersion of tracer is observed. Many limitations of the technique and an example of complex interpretation are discussed in detail. Final results are compared with those obtained from classical and other tracer methods. A general interpretation of all the data leads to some conclusions and hypotheses which suggest that the main part of water in the investigated aquifer (part of the Vienna Basin) flows very quickly through highly permeable zones and that the movement of water probably takes place mainly in the upper layers of the aquifer. (auth)

19069 INVESTIGATIONS INTO GROUNDWATER BALANCE BY APPLYING RADIOISOTOPE TRACERS. Ubell, K. (Research Inst. for Water Resources, Budapest). pp 521-30 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

In loose sediments with a pore-type porosity two general types of water movement influencing the groundwater balance at natural conditions must be distinguished, namely; water transfer of vertical direction in unsaturated soils, i.e., water movement in the aeration zone above water table; and water movement in the saturated zone, i.e., horizontal flows in groundwater body. Owing to numerous factors, groundwater balance is a highly complex process. For determining the quantitative features, experimental field tests are of great importance. The methods used and the results obtained in Hungary in connection with field tests applying radioactive tracers for solving the problems of natural groundwater balance are presented. Moisture movements taking place through the aeration zone and, based on this process, the recharge due to precipitation and the evaporation loss of groundwater have been determined by systematic soil-moisture measurements carried out in whole vertical profiles, from the land surface down to the water table, with the aid of neutron-diffusion, based on the application of radioactive isotopes of Pu–Be source-detector as neutron radiation emitter. The flow of groundwater, i.e., the natural horizontal movement in the zone of aeration, and also the velocity distribution according to depth and the natural flow-rate of groundwater, were studied by multi-well tracing and single-well techniques by using ^{131}I tracers. (auth)

19070 BOREHOLE DILUTION TECHNIQUES: A CRITICAL REVIEW. Halevy, E. (IAEA, Vienna); Moser, H.; Zellhofer, O.; Zuber, A. pp 531-64 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

Borehole dilution techniques for the determinations of filtration velocity, vertical flows and direction of groundwater flow are reviewed. The principles underlying each measurement, instrumentation, disturbing influences, and their possible correction are discussed and recommendations are made for applications and future research. (auth)

19071 LOCALIZATION OF LEAKAGES FROM A LARGE RESERVOIR USING RADIOACTIVE TRACERS. Guizerix, J. (CEA, Grenoble, France); Molinari, J.; Gaillard, B.; Santos Cottin, H.; Mornas, A.; Corda, R. pp 587-99 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967. (In French).

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

It is very important, from the point of view of both safety and economy, to detect losses from water-storage systems designed for irrigation or power production. An experiment is described which enabled the determination of the source of losses from an earth dam. The zones of infiltration were determined by injecting radioactive tracers in the lake at points or along lines, over distances of about 50 m. The radioactivity of the water was then checked at the outlet from the dam's drains, and curves were prepared showing the point at which the radioactive cloud reached the bottom of the water in the reservoir; this was done by using a nuclear probe lowered over the side of a boat whose position was plotted from the bank. The envelope of the curves obtained when activity is detected at the outlet of the drains defines the infiltration area of the lost water. A detailed explanation of the technique is given and the modifications which might be necessary to suit special situations which can arise are discussed. These consist of using tracers easily adsorbed on to the bottom of the stored water, the use of labelled sediments, and the injection of tracers through pierced tubes placed at the bottom of the reservoir. (auth)

19072 RADIOMETRIC METHOD OF SEEPAGE CONTROL IN DAMS AND THEIR ENVIRONS. Makovski, E. pp 601-16 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967. (In Russian).

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

A problem of current importance in hydrotechnology is seepage and the problems connected with it, such as impermeability of dams and their foundations, the working of narrow mine shafts, etc. Of the many approaches used to investigate these questions, the simplest and most successful is the radiometric method. Radiometric observation of the flow of water in hydrotechnical constructions involves introducing at a fixed point in the flow of water an aqueous radioactive solution, and then following its movement and finding the places where it flows using the appropriate detectors arranged at fixed or variable control points. On the basis of a few years' investigations in field conditions, the means of choosing the injection point, the technique for introducing the radioactive solution into the soil and the conditions that must be borne in mind when selecting the radioisotope and determining its optimum activity are described. The methods of measurement used are also indicated, and a brief description of the equipment is given. Included in the discussion of the choice of injection site is a description of a small probe developed for this purpose; it measures the volumetric weight of the soil, which is used to determine the most suitable injection point, this being the region where the soil is most permeable. The radioisotopes used in the investigations were ^{51}Cr in the form Na_2CrO_4, ^{82}Br in the forms KBr and NH_4Br, ^{131}I in the forms NaI and KI, ^{124}Sb in the form $SbCl_3$ and ^{198}Au in the form $HAuCl_4$. Their adsorption values are given for pure sand soils, sand and clay mixtures and rocky soils (granite). The positive results are also given of the investigations carried out in several directions simultaneously using the radioisotopes ^{82}Br, ^{131}I and ^{198}Au. A short review of the progress of field investigations carried out on several dams in Poland and the results achieved are given. The possibilities which this method affords for the solution of hydrotechnical problems are described. It is used to determine the actual speed and direction of water flow in the section of soil investigated, and also to determine whether an increased flow is of the percolation or the cleft type, the point of origin of increased seepage of hydraulic breakthrough, the cross section of the weakened soil, the depth to which damage to the vertical impermeable screen has occurred and the impermeability of the horizontal screens. (auth)

19073 FUNDAMENTALS OF THE DISPERSION OF RADIONUCLIDES IN SANDY AQUIFERS. Baetsle, L. H. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.); Souffriau, J. pp 617-28 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

Injections of radioactive trace substances into homogeneous aquifers may be designed under well-defined conditions. If the radiotracer is not absorbed by the solid phase the pulse shape has a symmetric form that may be described mathematically by the classical diffusion equations. The magnitude of the dispersion coefficients and how they must be determined are discussed in detail. The problem of asymmetric pulse-shapes occurring with slightly delayed isotopes is approached from two directions. The leading and trailing parts of the distribution curve may be considered as forming part of two different normal distributions with two dispersion coefficients. An example of this approach is worked out in detail. The asymmetric pulse-shape can be described analytically as a homogeneous concentration/distribution curve but the computation method is very complicated. Some limitations of this approach are discussed from the fundamental as well as from the computational point of view. (auth)

19074 LABORATORY EVALUATION OF ^{51}Cr-EDTA AS A TRACER FOR GROUNDWATER FLOW. Knutsson, G. (Chalmers Univ. of Tech., Gothenburg, Sweden); Forsberg, H. G. pp 629-52 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

Over a number of years the ^{51}Cr-EDTA-complex has been successfully employed for tracing groundwater movement. The increasing use of this compound has led to a thorough laboratory evaluation of its applicability which is reported here. The investigations consist of four main parts: investigations into the preparation and purity control of ^{51}Cr-EDTA. The complex formation has been studied in some detail and certain modifications of earlier procedures for the preparatory work are suggested in order to ensure a complete reaction. Various methods to test the completeness of complex formation have been worked out; analysis of simultaneous determination of ^{51}Cr and ^{3}H- in many cases spiking of the ^{51}Cr tracer with tritium is advantageous, and a procedure has been worked out for the simultaneous determination of ^{51}Cr and ^{3}H by liquid-scintillation counting. This technique has proved to be particularly useful when the samples are not very weak; the application of a flow cell to laboratory and field work. The use of a flow cell for continuous recording during column tests has been studied, and the possibility of applying this method to field investigations is discussed. Investigations into the behavior of ^{51}Cr-EDTA in various mineralogical environments and in different kinds of soils. Some 150 column tests have been executed with 20 different minerals, five types of rocks and six different soils, ^{3}H being used together with ^{51}Cr-EDTA as a reference tracer. ^{51}Cr-EDTA, at concentrations down to 0.001 ppM, is neither adsorbed nor considerably retarded in primary minerals such as quartz, feldspars, some micas, calcite and dolomite; some of the ferromagnesian silicates and other iron-bearing minerals have a considerable effect upon ^{51}Cr-EDTA. Upon passage through secondary minerals, such as clay minerals, ^{51}Cr-EDTA is retarded, and chlorite particularly causes a marked delay. Losses of the complex seem to occur in illite. On the other hand, it was found that ^{3}H is retarded more than ^{51}Cr-EDTA in bentonite and in montmorillonite, and to some extent in the other clay minerals, besides chlorite. Variation in pH or in flow-rate does not affect the behavior of ^{51}Cr-EDTA. All data from the laboratory tests were given a specially designed statistical treatment and a computer technique was used. Finally, some recent field experience of the use of ^{51}Cr-EDTA in Sweden and elsewhere is discussed briefly. (auth)

19075 APPLICATION OF THE INTEGRATION METHOD TO THE DETECTION OF WATER-BORNE ^{51}Cr-EDTA AND RADON ON ACTIVATED CARBON. Molinari, J.; Guizerix, J. (CEA, Grenoble, France). pp 653-68 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967. (In French).

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

The choice of a tracer for groundwater hydrology depends on the behavior of the tracer in relation to the ground it passes through and on the sensitivity with which it can be detected. A proposal is made for using ^{51}Cr-EDTA, which is recognized as a good radioactive tracer for groundwater, in a method applied successfully for the detection of fluoresceine, in which enrichment is achieved by dripping labelled water onto activated carbon. As the steric hindrance of fluoresceine is of the same order of magnitude as that of Cr-EDTA, it is to be expected that the activated carbon method will result in a useful degree of enrichment in Cr-EDTA. This hypothesis was confirmed and the experiment was extended to very low concentrations. It was found that the radioactivity of the tracer was then partly masked by the natural radioactivity fixed in the carbon. Almost all the natural radioactivity thus fixed was due to radon daughters dissolved in the water. The artificial tracer can be distinguished from radon

descendants by differential gamma spectrometry. Measurements can be made with a single carbon sample 50 to 100 ml in volume. Laboratory experiments with very dilute solutions of ^{51}Cr-EDTA disclosed a detection sensitivity such that it is theoretically possible to label 10^9 m^3 of water with 10 Ci of ^{51}Cr-EDTA. Radon can be measured quantitatively in the field, and the sensitivity of this method of measurement is rather similar to that of alpha scintillation measurements. Moreover, the sensitivity of the alpha method can be increased by running it in conjunction with the integration method referred to. (auth)

19076 RADIATSIONNAYA TEKHNIKA. VYPUSK I. (Radiation Techniques. Volume I). Shtan', A. S. (ed.). Moscow, Atomizdat, 1967. 360p.

Thirty-eight articles are included on radiation techniques. The articles cover a wide range of devices used in radiography, therapy, and radiodiagnostics. Radioisotopic installations for remote control operations, neutron generators, and x-ray diagnostic instrumentation are described. Neutron activation of spherical specimens and foils and electron reflection from solids are discussed. Data on the electrical parameters of thermoelectric generators, triple phase x-ray diagnostic devices, and neutron pulse generators are evaluated as well as industrial potassium concentration mills using radioisotopic potassium. Measurements of isotopic activity in high-activity sources, measurements and treatment of bremsstrahlung spectra, and measurements of fast neutron yield in a two-crystal spectrometer are analyzed. Technological and economic aspects of isotopic applications in industrial defectoscopy are also discussed. (R.V.J.)

Materials Testing

Refer also to abstracts 19007, 19177, 19466, and 19621.

19077 (AD-639053) GUIDE FOR INTERPRETATION OF NON-DESTRUCTIVE TESTS OF WELDS IN SHIP HULL STRUCTURES. (Coast Guard, Washington, D. C. Ship Structure Committee). Sept. 1966. Contract Nobs-90310. 26p. (SSC-177). CFSTI.

A survey of various Codes and Standards applicable to the interpretation of radiographs of welds is described. The Guide was developed for application to welds in ship hull structures of the general cargo, tanker and passenger class as differentiated from naval ships. The Guide exhibits typical X-ray and other nondestructive test results of several classes of defects with suitable text to delineate the maximum size and/or distribution that would be recommended as acceptable for ship hulls. (auth) (TAB)

19078 (TID-11295(Pt.1)(5th Ed.)) NUCLEAR FUELS AND MATERIALS DEVELOPMENT PROGRAM SUMMARY FOR 1965. Newman, Ruth Ann (ed.) (Division of Reactor Development and Technology (AEC), Washington, D. C. Fuels and Materials Branch). Jan. 1966. 271p. Dep. CFSTI.

Work performed under the unclassified programs of the Fuels and Materials Branch of the Office of Reactor Technology of the Division of Reactor Development and Technology is summarized for the calendar year 1965. Work is identified by site, rather than topic. (J.C.W.)

19079 (UCRL-70750) ACOUSTIC EMISSION: A NEW NONDESTRUCTIVE TESTING TOOL. Dunegan, H.; Harris, D. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 16, 1968. Contract W-7405-eng-48. 37p. (CONF-680304-1). Dep. CFSTI.

From 3rd Annual Symposium on Nondestructive Testing of Welds and Material Joining, Los Angeles, Calif.

A new approach to nondestructive testing is proposed which is centered around the concept of utilizing transducer action of a flaw in a stress field. This situation results in localized plastic deformation occurring in the vicinity of the flaw which in turn gives up energy in several ways. Thermal emission, exo-electron emission and acoustic emission are the three primary forms that this energy takes upon release. The first two are mentioned briefly and acoustic emission is reported in detail. Acoustic emission from unflawed tensile specimens can be treated from a dislocation dynamics approach. A very good correlation between the acoustic emission and a proposed theoretical model for mobile dislocation density as a function of plastic strain is shown for aluminum. A theoretical model for the plastic volume around a sharp crack in an elastic stress field previously developed, predicted that the summation of acoustic emission should vary as the fourth power of the stress intensity factor at the crack tip. Experimental data from 7075-T6 aluminum are shown that agrees well with this model. It is further shown that acoustic emission data from flawed specimens, interpreted from a fracture mechanics viewpoint, can find direct application for nondestructive quality assurance tests on engineering structures. (auth)

19080 METHOD FOR NONDESTRUCTIVE DETERMINATION OF THE FLUX DEPRESSION WITHIN FUEL RODS. Knoth, J.; Sandrock, F.; Schwenke, H. Atomkernenergie, 13: 116-18 (1968). (In German).

The influence of different radial distributions of the fission product density on the γ-self absorption has been investigated during non-destructive burnup determinations on irradiated fuel rods by γ-spectrometry. The minimum error of the burn-up determination leads to a distinct radial distribution and the corresponding flux depression. (auth)

19081 EXTENSION OF THE RANGE OF WALL THICKNESS DIFFERENCES EVALUABLE IN GAMMA-RAY FILM RECORDING. PART 3. THE MASKING TECHNIQUE. Becker, E.; Nens, U. (Technische Hochschule, Magdeburg, Ger.). Isotopenpraxis, 3: 409-13(1967). (In German).

The use of x-rays or gamma-rays in materials testing often shows too large a density volume because of the large differences in the sample thickness. In order to reduce the total contrast and to retain or intensify small differences of optical density the masking technique may be employed. Applying this technique has shown that the copies gained higher detail detectability. The method is rapid and little cumbersome. (auth)

19082 GAMMAMETRIC DETERMINATION OF CORE DISPLACEMENT IN CAST IRON. Wagner, F.-W.; Boerner, L.; Becker, E. (Technische Hochschule, Magdeburg, Ger.). Isotopenpraxis, 3: 456-8(1967). (In German).

A testing method for determining the core displacement in hollow cast metal pieces is described. The apparatus consists of a radiation source (500 μCi ^{192}Ir) which directs γ rays through the test casting to a scintillation detector in a carefully aligned collimator, and a Geiger counter. A known characteristic curve relates the counter output to the casting wall thickness. Therefore, the wall thickness at any radial point on the perimeter of the casting can be measured accurately and quickly, and the core displacement can be determined. (L.C.L.)

19083 METHOD AND SYSTEM FOR NON-DESTRUCTIVE INSPECTION OF VARIABLE DENSITY PLATES. Reynolds, J. W.; Stripling, H. J. Jr. (to United States Atomic Energy Commission). U. S. Patent 3,372,276. Mar. 5, 1968.

A method and system for the nondestructive inspection of variable density plates is described. In the system a plate, having a plurality of different required area densities, and a plurality of corresponding standards are automatically inspected in a plurality of incremental longitudinal passes of the plate and standards between a source of penetrating radiation and a detector therefor to thus effect an inspection of the major portion of the plate. The plate inspection involves injecting data from the standards into circuitry for comparison with data derived from the plate itself, with the result that plate areas which are out-of-tolerance are indicated on a chart recorder. (AEC)

Protective Structures

Refer also to abstract 19032.

19084 (ORNL-TM-1312(Vol.6)) STRUCTURAL ANALYSIS OF SHIPPING CASKS. VOLUME 6. IMPACT TESTING OF A LONG CYLINDRICAL LEAD-SHIELDED CASK MODEL. Klima, B. B.; Shappert, L. B.; Stoddart, W. C. T. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 36p. Dep. CFSTI.

Settling of lead in lead-filled fissile and radioactive materials shipping casks due to impact was investigated. The cask testing facility is described. Results indicate that when an unbonded cylindrical cask is subjected to an impact, lead will move relative to the steel shell. A mathematical model is developed to quantitatively predict the magnitude of the lead movement. Data acquired during the testing of a smaller model confirms the applicability of this developed equation to predict lead movement in an unbonded cask. (auth)

Radioactive Material Handling

Refer also to abstracts 18923 and 19021.

19085 (BNWL-687) EARTH SCIENCES WASTE DISPOSAL INVESTIGATIONS, JANUARY-JUNE 1967. Eliason, J. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 27, 1967. Contract AT(45-1)-1830. 18p. Dep. CFSTI.

Ground water samples were analyzed for gross β activity, for ^{106}Rh-^{106}Ru, and α activity of ^{137}Cs, ^{3}H, and ^{90}Sr. Gross β and tritium results are plotted on water table contour maps with iso-

concentration lines showing two-dimensional extent and direction of contamination spread. Disposal of waste to ground water has caused changes in quality of ground water due to salts in the wastes and mineral degradation in the soils. Concentrations of nonradioactive materials in the ground water are below recommended drinking water levels except for nitrates which are above the 45 ppM limit. (F.S.)

19086 (IN-1150) MANUAL OF PROCEDURES FOR EFFECTING CONTROL OF SS MATERIALS AT STATION JWC. Tingey, F. H.; Lewis, B. S. (Idaho Nuclear Corp., Idaho Falls). Jan. 1968. Contract AT(10-1)-1230. 38p. Dep. CFSTI.

Accounting and internal control practices related to receipt, storage, handling, and shipping of SS material at station JWC are outlined. The reporting requirements of Nuclear Materials management are described. (J.C.W.)

19087 (ORNL-3824(Suppl.1)) A COMPUTER CODE FOR STORING AND RETRIEVING DATA AND DEVELOPING IMPROVED SOLIDS FOR FIXATION OF HIGHLY RADIOACTIVE WASTES. Fitzgerald, C. L.; Godbee, H. W.; Davis, M. H.; Clark, W. E. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 27p. Dep. CFSTI.

A supplement is designed for arranging in order and comparing the data previously collected. Any data may be stored in the program. In the future, the code will aid in the prediction of new, improved solids for long-term storage of waste by using the collected and collated data. A flow chart for the FORTRAN II program used is given. (J.C.W.)

19088 TRANSIT FLASK FOR RADIOACTIVE OBJECTS. Brisac, Michel; Lefort, Guy (to Commissariat a l'Energie Atomique). British Patent 1,103,787. Feb. 21, 1968. Priority date May 21, 1965, France.

The design of a vessel for transporting radioactive objects is given. The vessel design provides for protection against gamma radiation by absorption of the radiation by a heavy material and for protection against alpha particles by the maintenance of absolute sealing-tightness. (J.C.W.)

Vacuum Engineering

19089 DESIGN OF THERMAL MANIPULATORS FOR ULTRAHIGH VACUUM. Crawford, C. K. (Massachusetts Inst. of Tech., Cambridge). J. Vac. Sci. Technol., 5: 37-41(Mar.-Apr. 1968).

Small, rugged, low-cost thermal manipulators have been developed for use in ultrahigh vacuum. When driven by a simple feedback loop using a thermocouple position sensor, they can provide accurate positioning along with response times of less than one sec. It is shown from thermodynamic considerations, however, that the work output for reasonable input energy is limited by the nature of the working substance, is fundamentally low, and that there is little hope of achieving significant improvement. Thus, the manipulators are useful only in applications where small forces are required, such as scanning beam, orienting a sample, or moving a shutter. (auth)

19090 GLASS ORBITRON PUMP OF 5-CM DIAMETER. Naik, Pramod K.; Herb, R. G. (Univ. of Wisconsin, Madison). J. Vac. Sci. Technol., 5: 42-4(Mar.-Apr. 1968).

A glass, orbitron pump of 5-cm dia was constructed and its performance studied. A stainless-steel mesh is used around the inside wall of the glass body to avoid difficulties due to peeling of titanium. Average pumping-speed values are 11.6 liters/sec for nitrogen, 5.6 liters/sec for air, and 0.1 liter/sec for argon in the range of pressures between 10^{-10} torr and 10^{-5} torr. (auth)

19091 ISOLATION OF ULTRAHIGH VACUUM SYSTEMS FROM OIL DIFFUSION PUMPS. Gretz, R. D. (Battelle Memorial Inst., Columbus, Ohio). J. Vac. Sci. Technol., 5: 49-53 (Mar.-Apr. 1968).

Surface diffusion and adsorption-desorption are the means by which oil is passed through traps in the molecular flow region. Surface diffusion can be excluded by using zeolite (or any equivalent molecular sieve material) on surface paths in the trap. Elimination of the absorption-desorption mechanism, however, requires somewhat more careful trap design. It is shown that a long isolation time (the length of time that a system will remain at the base pressure after processing for achievement of ultrahigh vacua, which is the usual criterion for evaluation of isolation methods) is a necessary but not a sufficient condition that must be met to insure complete isolation of a system from an oil diffusion pump. It is shown, using field-electron emission microscopy (FEM), that under certain conditions "oil" can be transferred into the vacuum system during bakeout and also under subsequent quiescent conditions. The use of a trap design that is an optical baffle (all internal trap surfaces see only a molecular sieve material, either zeolite or Fiberfrax) precludes "oil" transfer during bakeout, but does not exclude transfer under quiescent conditions. Addition of a Ti getter in-line between the molecular sieve trap and the high-vacuum chamber precludes "oil" transfer under all operating conditions. (auth)

INSTRUMENTATION

Radiation Detection Instruments

19092 TIME-OF-FLIGHT PARTICLE IDENTIFICATION TECHNIQUE. Emerson, S. T.; Simpson, W. D.; Jackson, W. R.; Chen, Y. S.; Phillips, G. C. (Rice Univ., Houston, Tex.). pp 1030-2 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

A time-of-flight particle identification technique has been developed and is being used in the investigation of several three-body final states. The technique has the advantage of wide dynamic range and also affords a significant reduction in the background of random coincidences. The $^{9}Be + p \rightarrow d + 2a$ reaction is discussed as an example of the application of the technique. (auth)

General Detectors and Monitors

Refer also to abstracts 18947, 19392, 20403, 20497, and 20974.

19093 (AERE-M-1929) THE INSTALLED TRITIUM MONITORING SYSTEM IN THE DIDO AND PLUTO REACTOR HALLS. James, B. T. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1967. 18p. Dep. CFSTI. UK 3s. 6d.

A description is given of new equipment installed in the DIDO and PLUTO reactor halls for the monitoring of tritiated water in air. Each unit of the installation is provided with twelve remote sampling points, and remote indication and warning facilities, and the system is free from interference from high gamma radiation fields. Two standard 1844A radioactive gas monitors are used in each unit, and the system has proved adequate for all operational monitoring requirements. Remote monitoring in the event of evacuation from the reactor buildings is provided. (auth) (UK)

19094 (EUR-3630) BIBLIOGRAPHY ON SEMICONDUCTOR DETECTORS. A Compilation of Selected Literature Abstracts as Guide to Recently Public Available R. and D. Publications in Semiconductor Radiation Detector Techniques Covering the Period, 1963-1967. Bock, E. (European Atomic Energy Community, Brussels (Belgium). Center for Information and Documentation). Dec. 1967. 138p. Dep.

A bibliography presenting 629 abstracts of publications dealing with semiconductor detector techniques covering the period 1963-1967 is presented. (auth)

19095 (IAE-1349) STSINTILLYATSIONNYI DETEKTOR NA PLENKAKH DLYA IZMERENIYA POLNOGO CHISLA ZAKHVATOV V REZONANSAKH REAKTSII (n,γ). (Film-Type Scintillation Detector for Measurement of the Total Number of Captures in the Resonances of the (n,γ) Reaction). Danelyan, L. S. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1967. 12p. (In Russian). Dep.

With the aid of the film-type scintillation detector, which displays a constant recording effectiveness with respect to the (n,γ) capture reaction from resonance to resonance, it is shown that the relative magnitudes of the total number of captures in resonances, required to calibrate the intensities of partial gamma-transitions from levels of the nucleus $^{155}Gd + n$, are determined by means of the NaI(Tl) crystal with a satisfactory accuracy (no worse than 5%). (auth)

19096 (INR-820/II/PS) ISPOL'ZOVANIE POLUPROVODNIKOVYKH DETEKTOROV DLYA EMISSIONNOGO RENTTENOVSKOGO ANALIZA. (On the Application of Semiconductor Detectors in the X-Ray Fluorescence Analysis). Pshiborski, V.; Khvashchevska, Ya.; Charnatski, V.; Shimchak, M. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 16p. (In Russian). Dep.

Some preliminary results on the possible application of semiconductor detectors for the qualitative x-ray fluorescence analysis are presented. Characteristic x-ray spectra of Mo, Ag, In, Sn, Ce, Au, Pt, Ta, W excited by γ-rays from ^{241}Am and ^{57}Co sources are presented. (auth)

19097 (NYO-3246-TA-1) RESEARCH ON AVALANCHE TYPE SEMICONDUCTOR RADIATION DETECTORS. Annual Report, January-December 1967. Huth, Gerald C.; Locker, Robert J. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Jan. 1968. Contract AT(30-1)-3246. 130p. Dep. CFSTI.

Developments in fabrication techniques and performance of avalanche semiconductor detectors are reported. Also, uses of avalanche detectors for tritium detection and biomedical applications are discussed. (W.H.K.)

19098 (ORNL-TM-1774) DESCRIPTION OF PROCESS RADIATION MONITORING INSTRUMENTATION IN THE TRANSURANIUM PROCESSING PLANT, BUILDING 7920. Holladay, J. H.; Knowles, D. J. (Oak Ridge National Lab., Tenn.). Jan. 25, 1968. Contract W-7405-eng-26. 19p. Dep. CFSTI.

Radiation monitoring instrumentation was installed in the Transuranium Processing Plant, Building 7920, to continuously monitor process areas and equipment for process analysis and control. Pipes carrying cell ventilation air and vessel off-gas are monitored before the gases enter the HFIR stack. Drain lines carrying process wastes are monitored in the pipe tunnel of Building 7920 and again before they enter the pond area. Radiation detectors are throughout the building at pipes, pumps, etc., for detection of an increase in radiation level in process piping. A radiation detector in each cell measures radioactivity of materials before they are removed from the cell. The equipment used and the overall operation of the systems are described. Drawing references and a check-out procedure for the vessel off-gas monitoring system are included. (auth)

19099 (UCID-4675) RESPONSE OF WEAPONS DETECTORS TO FAST RISING SIGNALS. PART I. THE DETECTOR RESPONSE FUNCTION. Dickinson, W. C.; Lauzon, A. F.; Neifert, R. D.; Lent, E. M. (California Univ., Livermore. Lawrence Radiation Lab.). June 1, 1963. Contract W-7405-eng-48. 50p.

The definition of response function and the convolution integral are presented for purposes of predicting detector performance and interpreting detector signals. Response functions are determined for a Cherenkov photodiode detector a fluor photodiode detector, a fluor photomultiplier detector, a vacuum Compton diode, and a fully-depleted silicon p-n semiconductor detector. (W.H.K.)

19100 (UCRL-70773) SCINTILLATION CHARACTERISTICS OF THIN NaI(Tl) AND CsI(Tl) LAYERS FABRICATED BY VACUUM DEPOSITION. Bauer, Rudolf W.; Weingart, Richard C. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 19, 1968. Contract W-7405-eng-48. 13p. (CONF-680207-1). Dep. CFSTI.

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C.

The scintillation characteristics of thin vacuum-deposited layers of NaI(Tl) and CsI(Tl) were investigated. Scintillation layers with thicknesses ranging from 0.2 to 20 mg/cm^2 were evaluated as detectors with 6- and 22-keV x rays. In this energy region they were found to be comparable in performance to the thicker, commercially available NaI(Tl) and CsI(Tl) scintillation crystals. Fabrication methods, scintillator evaluation techniques, and applications in selective low-energy x-ray detection will be reported. (auth)

19101 (UR-49-903) EVALUATION OF A REM RESPONDING NEUTRON DETECTOR FOR USE AROUND THE UNIVERSITY OF ROCHESTER'S 20 MeV EMPEROR TANDEM VAN DE GRAAFF ACCELERATOR. Gifford, Bernard R.; Mermagen, Herbert; Maillie, H. David (Rochester Univ., N. Y. Atomic Energy Project). Feb. 9, 1968. Contract W-7405-eng-49. 25p. Dep. CFSTI.

The accuracy of the Bonner Sphere Neutron Detector in measuring the dose equivalent (DE) for neutron reactions produced by the University of Rochester's 20 MeV Emperor Tandem Van de Graaff Accelerator is evaluated by experimental and theoretical means. Results show that the Bonner Sphere is rem responding within ±30% for a number of neutron distributions produced by (p,n) (d,n), and (heavy ion,n) reactions with maximum energies up to 25 MeV. A method of analysis is used which could be used to evaluate other neutron detectors, both rem- and non-rem responding. (auth)

19102 CALCULATION OF THE AGREEMENT OF THE SIGNAL-TO-NOISE RATIO IN AN EXPERIMENT FOR THE CORRELATION OF PHOTONS EMITTED IN CASCADE. Dumont, A. M.; Camhy-Val, C. (CNRS, Paris). Nucl. Instrum. Methods, 60: 329-32(Apr. 1968). (In French).

The signal-to-noise ratio is calculated for an experiment which involves correlated photons from an atomic cascade. The finite source depth is taken into account. (auth)

19103 STANDARDISATION OF BETA-GAMMA EMITTERS BY EXTRAPOLATION OF COINCIDENCE MEASUREMENTS WITH VARIATED ELECTRICAL PARAMETERS. Klumpar, Josef; Majerova, Miroslava; Ulicny, Jan (Inst. of Nuclear Research, Prague). Jad. Energ., 14: 98-100(Mar. 1968). (In Czech).

A newly proposed method for the realization of different counting efficiencies of the beta channel by variation of the electrical parameters of the counting device was experimentally tested with calibrated sources of ^{60}Co and ^{131}I. It was found more convenient as the commonly practiced methods consisting in increasing of sample weight or inserting of additional filters which are much more laborious. (auth)

19104 A 4π LIQUID-SCINTILLATION WHOLE-BODY COUNTER. I. DESIGN, OPERATING CHARACTERISTICS, AND CALIBRATION. Kessler, W. V.; Ziemer, P. L.; Christian, J. E.; Shaw, S. M. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-876. Int. J. Appl. Radiat. Isotop., 19: 287-92(Mar. 1968).

A 4π large-volume liquid-scintillation counter composed of two 2π detector tanks is described. This counter is used primarily for measuring ^{40}K activity in human beings and large animals. (auth)

19105 FLUCTUATION ERRORS IN IONIZATION CURRENT MEASUREMENTS. Doerfel, G. (VEB Vakutronik, Dresden). Kerntechnik, 10: 50-3(Jan. 1968). (In German).

From the mean square fluctuation error of a ratemeter, conclusions may be drawn concerning measuring time, least instrument reading, etc. The conditions are discussed which must be fulfilled in order to make these conclusions valid for current measurements with ionization chambers, photomultipliers and proportional counters, too. (auth)

19106 TECHNIQUES FOR MINIMIZING EDGE EFFECTS IN NUCLEAR EMULSIONS. Kinzer, R. L.; Seeman, N.; Share, G. H. (Naval Research Labs., Washington, D. C.). Nucl. Instrum. Methods, 60: 340-2(Apr. 1968).

The usable volume of nuclear emulsion stacks can be extended to within 25-μm from an edge using relatively simple techniques to reduce the amount of blackening and distortion. (auth)

19107 NEW "SHELF STRUCTURE" FOR LITHIUM DRIFTED SILICON DETECTORS. Schuler, W. (Ortec Inc., Oak Ridge, Tenn.). Nucl. Instrum. Method, 60: 278-80(Apr. 1968).

A lithium-drifted semiconductor detector develops an n-type surface layer where the intrinsic region is exposed to normal ambient atmosphere. The presence of this layer results in an undesirable increase in leakage current and noise, above a certain detector voltage. This difficulty must be overcome in order to achieve a short collection time while still maintaining a low noise level. Lothrop and Goulding propose to solve the difficulty by a double drift geometry in which this n-type channel is pinched off by providing a high transverse field region. The geometry proposed also ensures a high transverse field region, but it is achieved by different means. A source-limited diffusion on certain parts of the wafer is accomplished by controlling the local deposition rate of lithium on a silicon wafer during the lithium diffusion. A shelf-like structure automatically results after drifting. This shelf has a field gradient which ensures the pinch-off of the n-type channel beginning at low voltages. (auth)

19108 METHOD FOR THE IMPROVEMENT OF SIGNAL/NOISE AGREEMENT FOR FISSION CHAMBERS OPERATING AS PULSE CHAMBERS. Mantakas, Ch.; Polychronakis, G. (Democritos Centre d'Etudes Nucleaires, Athens). Nucl. Instrum. Methods, 60: 281-3(Apr. 1968). (In French).

A method is described which permits the improvement of the signal-to-noise ratio in a system counting the α particles of a fission chamber, operating as a pulse chamber. This is achieved by picking-up two simultaneous signals of opposite polarity, obtained from the anode and the cathode, and adding them in a differential amplifier. The device which employs conventional fast current preamplifiers, permits counting of pulses of the order of 100 nA, that is, of the same order as those given by neutron capture in a non-proportional boron chamber. (auth)

19109 CALCULATION OF DOUBLE ESCAPE PEAK ANGULAR CORRELATION ATTENUATION COEFFICIENTS FOR SQUARE Ge(Li) GAMMA DETECTORS. Ingebretsen, F. (Univ. of Oslo). Nucl. Instrum. Methods, 60: 308-16(Apr. 1968).

Angular correlation attenuation coefficients for the double escape peak are calculated for nine Ge(Li) detectors, by the use of a simple Monte Carlo technique. The calculations are valid for photon energies between 1.5–6 MeV. The statistical model used is empirically adjusted to fit the observed intrinsic efficiency for energies from 6 to 10 MeV. This gives an approximation to the attenuation coefficients for these energies. The coefficients are compared to the "any interaction" attenuation coefficients. (auth)

19110 NEUTRON DETECTION SYSTEM FOR THE STUDY OF THE (γ,n) REACTION WITH A LINEAR ELECTRON ACCELERATOR. Fukuda, K.; Okabe, S.; Sato, Y. (Radiation Center of Osaka Prefecture). Nucl. Instrum. Methods, 60: 297-300(Apr. 1968).

A neutron detection system has been designed to measure photoneutrons produced by a linear electron accelerator under an intense x-ray burst. It consists of BF_3 counters, a paraffin scatterer and some shieldings. The uniformity of the efficiency of the detection system is experimentally verified from thermal neutron energy up to about 5 MeV. The neutron yield curve near the threshold of $^{13}C(\gamma,n)^{12}C$ reaction was observed with this detection system. (auth)

19111 A PHOTOMETRIC DEVICE FOR THE IDENTIFICATION OF MULTIPLY CHARGED PARTICLES STOPPING IN NUCLEAR EMULSIONS. Kristiansson, A.; Ladd, A.; Malmqvist, L. (Univ. of Lund, Sweden). Ark. Fys., 34: 139-52 (1967).

A track photometer suitable for the identification of multiply charged particles stopping in nuclear emulsions is described. The apparatus consists of a microscope whose eye-piece is replaced by a slit system and a photomultiplier connected to a pen recorder. The image of the track moves across the narrow slit, placed in front of the photomultiplier, and absorption profiles are obtained and registered by the recorder. The particle charge is obtained from the mean widths of the profiles. The standard error of the charge determinations amounts to about 0.2 units of charge in the interval $3 < Z < 10$ when a residual range of 800 μ is measured. Emulsion distortion effects seem to increase the errors in the charge determination of particles heavier than oxygen. (auth) (Swed)

19112 PROPORTIONAL COUNTERS AND THEIR UTILIZATION IN RADIOPROTECTION. I. CHARACTERISTICS OF PROPORTIONAL COUNTERS. UTILIZATION OF PROPORTIONAL COUNTERS FOR THE DETECTION AND DOSIMETRY OF NEUTRONS. Joffre, H.; de Kerviler, H.; Tardy-Joubert, Ph. (CEN, Saclay, Gif-sur-Yvette, France). Radioprotection, 2: 1-32(1967). (In French).

Proportional counters are used practically in all areas of the detection and dosimetry applied to radioprotection. The essentially practical characteristics of proportional counters are reviewed and the possibilities for their use in the detection and dosimetry of fast neutrons are presented systematically. The practical conditions to be realized are studied in detail according to measurements of flux, mean energy, absorbed dose, and equivalent dose. The physical data necessary for the interpretation of the measurement results are given. The advantages and inconveniences of the use of a discrimination threshold applied to the pulses produced by proportional counters with the purpose of eliminating the pulses due to ambient γ radiation are shown. (tr-auth)

19113 GAMMA SPECTRUM ANALYSIS AND NEUTRON FLUENCE DETERMINATION WITH THE USE OF AN EL-X8 ELECTRONIC COMPUTER. Struch, H. P.; Zijp, W. L. (Reactor Centrum Nederland, Petten). Atoomenergie Haar Toepass., 9: 238-46(Nov. 1967). (In Dutch).

The use of the EL-X8 computer to evaluate gamma spectra from neutron-activated samples is described. The computer is used off-line and punched tape is used for information storage. The computer analyzes the gamma spectra, corrects for null-effects, compares with reference spectra, determines the activity of the sample, and ultimately the neutron fluence to which the sample was exposed. The program and its subroutines are described in general terms. An example of an activated (^{54}Fe and ^{59}Fe) sample is discussed in detail. (JJTB)

19114 EFFICIENT DESIGN FOR LUCITE LIGHT PIPES COUPLED TO PHOTOMULTIPLIERS. Hinterberger, H.; Winston, R. (Univ. of Chicago). Rev. Sci. Instrum., 39: 419-20(Mar. 1968). (COO-1701-1).

It is shown that the ratio of entrance area to exit area of Lucite light pipes can be increased by a substantial factor equal to $n^2/(n^2-1)$, where n = index of refraction of the light pipe material. For Lucite ($n \simeq 1.5$) this equals 1.8 and represents an effective increase of photocathode area by this amount. Results are included for a UVT Lucite light funnel with exit diameter of 4.6 cm when coupled to a plastic scintillator via a twisted light pipe. (B.G.D.)

19115 SCINTILLOMICROSCOPE FOR RADIOACTIVE TRACER DETECTION. Reynolds, George T. (Princeton Univ., N. J.). Contract AT(30-1)-3406. Rev. Sci. Instrum., 39: 298-302(Mar. 1968). (NYO-3406-6).

An image intensifier-microscope system is described that is capable of viewing the spatial distribution of weak radioactive tracer deposits in biological specimens. The radioactive decay products are located by means of the light they emit from thin scintillators placed over the specimen. Comparisons are made

with conventional autoradiographic techniques. An analysis is given of the sensitivity of the system. Results obtained from the application of the technique to ^{14}C detection in Schistosoma mansoni are presented and discussed. (auth)

19116 APPLICABILITY AND SENSITIVITY OF GM-COUNTERS FOR LIQUIDS IN DETERMINATION OF RADIONUCLIDES AND THEIR MIXTURES. Picer, M.; Popovic, V. (Inst. of Medical Research and Industrial Hygiene, Zagreb). Arh. Hig. Rada Toksikol., 18: 179-88(1967). (In Slovak).

The sensitivity of measurements by means of a GM 20 th Century Electronics counter for liquids of total beta-activity due to the presence of ^{40}K, ^{137}Cs, ^{131}I, ^{144}Ce, ^{141}Ce, ^{89}Sr, ^{32}P, ^{47}Ca, ^{36}Cl, and ^{60}Co in aqueous solutions was determined. Measurements were also carried out on an artificial mixture of fission products consisting of beta-activity on liquid samples by means of the counter were found to be sensitive. The results indicated that the method applied is suitable for determination of the radioactive contamination of water in emergency situations. (JPRS)

19117 FABRICATION, PROPERTIES, AND APPLICATIONS OF Ge(Li) GAMMA DETECTORS. Adams, F. (State Univ. of Ghent). At. Energy Rev., 5: 31-92(1967).

Gamma-ray spectrometry has progressed rapidly as a result of the development of lithium-drifted germanium detectors. In both pure nuclear research and in applied spectrometry the excellent resolution and the good detection efficiency of these devices is now fully recognized. The fabrication of detectors of different types, such as planar and coaxial, taking into account the practical difficulties such as lithium precipitation, drift failure, and surface leakage current is described. The instrumentation including preamplifier, amplifier, analyzing equipment, and the problems associated with very high resolution spectrometry, are briefly reviewed. The characteristics of different types of detectors, such as energy and time resolution and detection efficiency, are mentioned. A number of applications in analytical and radiochemistry are discussed. These include activation analysis, x-ray fluorescence analysis, and fission-product studies. (auth)

19118 ABSORBED DOSE CALIBRATION OF THIMBLE CHAMBERS WITH HIGH ENERGY ELECTRONS AT DIFFERENT PHANTOM DEPTH. Svensson, H.; Pettersson, C. (Univ. of Umea, Sweden). Ark. Fys., 34: 377-84(1967).

Calibration in a water phantom of commercial cylindrical ionization chambers in units of absorbed dose per ionization unit in the energy range of 5 to 30 MeV is described. The dependence of the calibration factors on different radiation field parameters such as the mean energy of the primary electrons at different depths, field size and collimating system were studied with the ferrous sulfate dosimeter as a reference. The results show that the calibration factors within the measurement accuracy can be regarded as exclusively dependent on the mean energy of the primary electrons at respective depths. Other parameters have little or no influence. Different ionization chambers give consistent results if their exposure calibration with ^{60}Co gamma-radiation is taken as a measure of the ionization and if parameters such as recombination losses and geometrical extension are eliminated. An intercomparison between the experimental results and theory gives good agreement. (auth) (Sweden)

19119 THE HALF-COLUMN TYPE PIN DIODE. Koyama, Masaki; Yuki, Makoto (Musashi Inst. of Tech., Ozenji, Japan). J. Nucl. Sci. Technol. (Tokyo), 5: 18-21(Jan. 1968).

Diodes of half-column structure were investigated. Half-column type Ge (5 cm^3) and Si (3 cm^3) diodes were prepared by air drifting in water coolant. The capacitance of 10 and 16 mm drifted half-column diodes were found to be about 2 pF at 200 V. The fwhm with an E180F preamplifier was 10 keV at 1.33 MeV γ-energy at relatively low bias voltage (200 V). The techniques of preparation and the performance characteristics obtained with the half-column type diode are described. (auth)

19120 FISSION PRODUCT MONITORING IN WATER COOLED REACTORS BY DETECTION OF HARD GAMMA RADIATION. Strindehag, O. (Aktiebolaget Atomenergi, Studsvik, Sweden). Atomkernenergie, 13: 119-24(1968).

A fission product monitor is described in which the hard gamma radiation from a few fission products, particularly ^{87}Kr, ^{88}Kr and ^{89}Kr, is detected. The monitor has a spherical sample container with a volume of 230 cm^3 and a scintillation detector with a 3'' × 3'' NaI(Tl) crystal. The discriminator level corresponds to a threshold energy of 2 MeV, and to improve the relative sensitivity for hard gamma radiation a lead plate can be placed between sample container and detector. Special interest is devoted to the reduction of the pileup background from ^{41}Ar. (auth)

19121 THIRD MOMENT OF THE NUMBER OF NEUTRONS DETECTED IN SHORT TIME INTERVALS. Furuhashi, Akira; Izumi, Akira (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo), 5: 48-59(Feb. 1968).

The fluctuation in neutron counts occurring in the course of short time intervals has been mathematically formulated up to the third moment. Second and the third order fluctuation parameters representing the degree of neutron correlation in the system are derived as functions of time interval in a form that is independent of the counter efficiency. It is suggested that measurement of the effective multiplication factor of the system is possible by comparing the third order parameter with the square of that of the second order. (auth)

19122 THE USE OF CHERENKOV RADIATION IN THE MEASUREMENT OF β-EMITTING RADIONUCLIDES. Elrick, R. H.; Parker, R. P. (Inst. of Cancer Research, Surrey, Eng.). Int. J. Appl. Radiat. Isotop., 19: 263-71(Mar. 1968).

Cherenkov radiation produced in an aqueous medium by β-emitting radionuclides of energy greater than 260 keV was investigated as a means of radioassay. Compared with liquid scintillation techniques sample preparation is simple; sample volumes up to 20 ml may be counted, and the efficiency is unaffected by chemical quenching. Due to the low photon yield the method is only practicable for radionuclides emitting β-particles of energy >1 MeV. The detection efficiency was studied as a function of β-energy; representative values are 25 percent for ^{32}P and 62 percent for $^{106}Ru-^{106}Rh$ using a commercial liquid scintillation counter fitted with two photomultiplier tubes in a fast coincident circuit. Colour and ultraviolet quenching can be serious, and methods of correction were studied; external standardization, decoloration and the use of ultra-violet filters were shown to be convenient techniques. The counting efficiency is improved by using quartz apparatus, incorporating wavelength shifters, and (because of the directional nature of Cherenkov radiation) by using a non-coincidence circuit. (auth)

19123 CURRENT AND CHARGE PULSES GIVEN BY COAXIAL Ge(Li) RADIATION DETECTORS. Poenaru, D. N. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 951-62(1967).

Current and electric charge pulse shapes, obtained for the collection of only one electron-hole pair released by an ionizing event in the sensitive volume of coaxial Ge(Li) detector cooled at liquid nitrogen temperature, were calculated. By considering the pairs generated in close vicinity of the detector electrodes, as well as those created in an intermediate region, maximum and minimum durations of the current pulses have been found. Low electric field intensity is assumed (charge carrier velocity directly proportional to the electric field intensity). (auth)

19124 SURFACE-BARRIER p-TYPE SILICON COUNTERS FOR α PARTICLES. Maksimov, Yu. S.; Rodionov, Yu. F.; Yavlinskii, Yu. N. Sov. Phys.-Semicond. (Engl. Transl.), 1: No. 7, 867-9(Jan. 1968).

A possible mechanism of the formation of a surface-barrier p-n junction in p-type silicon is considered, taking into account the influence of an oxide film. A method is described for the preparation of counters from high-resistivity ($\rho \approx 800\ \Omega \cdot cm$) p-type silicon and the parameters of these counters are reported. The counters were used in spectrometric detectors for α particles of ≈6 MeV energy. An energy resolution of ≈1% was obtained. (auth)

19125 SCINTILLATION COUNTERS FOR DIRECT MEASUREMENT OF THE RADIOACTIVITY OF CLEAR LIQUIDS. Amov, B. G.; Amov, I. G.; Vankov, I. D.; Kamburov, Kh. K. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 20: 903-6(1967). (In Russian).

A scintillation counter for the direct measurement of the radioactivity of clear liquids is described. The transducer of the counter consists of a spherical vessel with reflecting walls in which is fastened a number of films of plastic scintillators. The liquid to be measured, filling the vessel, acts as photowater, which allows the use of a scintillator with a large contact surface. The scintillation is registered by two photoelectric multipliers, connected in a coincidence circuit. For reduction of the cosmic-ray background, the vessel is shielded with lead and a G-M counter is connected in an anticoincidence circuit with the scintillation counter. The dependence of the efficiency of registration and the background on the contact surface of the scintillator and the voltage of the photomultiplier was determined. The role of the reflecting walls of the vessel was also studied. (tr-auth)

19126 AIR PROPORTIONAL ALPHA DETECTOR. Sparks, James R. (to United States Atomic Energy Commission). U. S. Patent 3,372,295. Mar. 5, 1968.

An air proportional alpha detector is described. It consists of a removable screen sealed with an aluminized mylar film re-

movably mounted on a metal coated plastic housing, a removable detector unit positioned within the housing adjacent the screen and including a plurality of longitudinal channels each having a wire independently suspended along the channel, and an aluminized mylar film seal adhesively bonded over the channels sealing the detector unit. (AEC)

19127 METHOD OF AND APPARATUS FOR THE ANALYSIS OF RADIOACTIVE AEROSOLS. Dieval, Michel; Dupoux, Jean; Joffre, Henri; Pradel, Jacques (to Commissariat a l'Energie Atomique). British Patent 1,104,349. Feb. 21, 1968. Priority date June 28, 1965, France.

The method consists of passing the air through a filter strip driven with a uniform movement, continuously measuring by means of a detector the activity of aerosols deposited on the strip, and varying the degree of exposure of the strip to the aerosols in predetermined steps. (W.H.K.)

19128 PROCESS FOR MANUFACTURING NEUTRON DETECTORS AND THE RESULTING PRODUCTS. Minjolle, Louis; Sagot, Marcel (to Commissariat a l'Energie Atomique). British Patent 1,103,886. Feb. 21, 1968. Priority date May 26, 1964, France.

The process consists of hot spraying an oxide onto a plane surface to form a support layer whose area is greater than the area of the detector, hot spraying a sensitive layer onto the support layer, separating the support layer from the plane surface, and cutting the resulting product to the required dimensions. (W.H.K.)

19129 APPARATUS HAVING OPPOSING CIRCUITS OF DIFFERENT TIME CONSTANTS FOR DETECTING BETA AND GAMMA RADIATION IN THE PRESENCE OF BACKGROUND RADIATION. Roulet, Roger (to Commissariat a l'Energie Atomique). U. S. Patent 3,364,353. Priority date Jan. 16, 1963, France.

A β and γ radiation detection device for measuring radiation in the presence of heavy background radiation is described. It consists of two integrator circuits, a plurality of elements responsive to the radiations to be detected, said circuits being connected to buck each other, and an indicator directly connected to said circuits for comparing the signals from said circuits, said circuits having different time constants. (U.S. Pat. Gazette)

19130 MASURAREA RADIATIILOR NUCLEARE CU DISPOZITIVE SEMICONDUCTOARE. (Measurement of Nuclear Radiations by Means of Semiconductor Devices). Poenaru, D. N.; Vilcov, N. Bucharest, Editura Academiei Republicii Socialiste, Romania, 1967. 374p.

As a result of their many advantages, in particular their excellent energy resolution, semiconductor detectors became widespread; it may be expected that within a short time period, they will represent the most widely used type of detectors. For this reason, the state of the art and the fundamental principles needed to understand research trends in this field, were reviewed in detail. Of the seven chapters, the first two, interaction of radiation and matter, and fundamental processes in metals and semiconductors, examine the pertinent concepts of atomic and solid-state physics. The special case of germanium and silicon is handled with special attention. The elementary physical processes which take place under the influence of nuclear radiations and generate electric charge pulses, are discussed in Chapter III, while in the next chapter the electric and radiometric properties of the semiconductor detectors are examined, considering points of interest to both researchers and instrument designers. Chapter V describes the various, currently available semiconductors and their specific applications. Keeping in mind the importance of an adequate electronic system, the operational characteristics of electronic circuits based on transistors and tubes are reviewed. (Monograph, 308 references). (TTT)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 18961 and 20578.

19131 (AERE-M-2016) SYNCHRONOUS DRUM STORE FOR NEUTRON TIME-OF-FLIGHT DATA RECORDING. Russell, M. C. B. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1968. 5p. Dep. CFSTI. UK 1s. 2d.

Proposals are made for the use of a synchronous recording drum as time-of-flight register and store for experimental neutron spectrometry. The drum would be driven at a fraction of chopper speed, and the data from each of an array of detectors would be stored on separate pages of the drum surface. An outline is given of the logical arrangement for writing data onto the drum and periodically reading it off into a paper tape punch. Such a system seems to offer an alternative to the on-line connection of a data processor to the experiment. (auth) (UK)

19132 (BNWL-669) ANALYSIS AND RETRIEVAL OF PROCESSED GAMMA SPECTRA DATA. Wells, E. L.; Weissenberger, W. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 57p. Dep. CFSTI.

Four analog- to-digital pulse converter--scintillation detector systems are connected on-line to a PDP-7 digital computer for immediate data processing. Aerosol, liquid, and deposition samples are analyzed. A description of components, coding methods, mathematical treatment, and analytical results is given. (W.H.K.)

19133 (BNWL-SA-1536) THE BATTELLE NORTHWEST ROTATING CRYSTAL AND PHASED CHOPPER SLOW NEUTRON SPECTROMETER. Harling, O. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1, 1968. Contract AT(45-1)-1830. 17p. (CONF-680501-1). Dep. CFSTI.

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark.

Performance and typical results with the present configuration of the Battelle Rotating Crystal time-of-flight spectrometer are presented along with future improvements. (B.G.D.)

19134 (JINR-P13-3718) Si(Li)-DETEKTORY I PREDUSILITEL DLYA SPEKTROMETRII S VYSOKIM RAXRESHENIEM KONVERSIONNYKH ELEKTRONOV I RENTGENOVSKOGO IZLUCHENIYA. (Si(Li)-Detectors and Preamplifier for High Resolution Spectrometry of Conversion Electrons and X-Rays). Bachone, V. F. Kushniruk; Subbotin, V. G.; Ter-Akop'yan, Z. A.; Kharitonov, Yu. P.; Zo Zung Sam (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 14p. (In Russian). Dep.

The method of designing Si(Li) detectors and preamplifiers for the spectroscopy of x rays and conversion electrons is described. The x ray spectra of ^{241}Am and ^{109}Gd sources as well as those of internal conversion electrons of ^{137}Cs and ^{109}Cd are given. The resolution (fwhm) for x rays of ^{241}Am is equal to 0.92 keV and for the conversion electrons of ^{137}Cs 2.6 keV. (auth)

19135 (ORNL-TM-2112) DORO 2: AN ORGANIC SCINTILLATOR PULSE-HEIGHT ANALYSIS CODE. Freestone, R. M, Jr. (Oak Ridge National Lab., Tenn.). Feb. 9, 1968. Contract W-7405-eng-26. 31p. Dep. CFSTI.

A number of methods presently exist for the unscrambling or unfolding of pulse-height spectra obtained through the use of an organic scintillator spectrometer system. Most of them suffer from the requirement of large computer capacity, and thus are not adaptable to small computer on-line or almost-on-line unscrambling, a desirable feature in the control of experiments. DORO-2, an unscrambling code written in the CAL language for the time-shared SDS-940 computer of the Com-Share system at Ann Arbor, Michigan, produces at the remote terminal at the experimental facility, an unscrambled spectrum within minutes of the conclusion of an experimental run, although these results are not as precise as those obtained with more elegant (and much more time-consuming) methods. Several comparisons of DORO-2 results with results from a more sophisticated code are presented, and an appendix contains a listing of the code and the input and output of a typical run. (auth)

19136 (UCRL-17901) HYPERCRYOGENIC DETECTOR-FET UNIT: CORE OF A HIGH-RESOLUTION SPECTROMETER. Elad, E.; Nakamura, M. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb. 7, 1968. Contract W-7405-eng-48. 20p. (CONF-680207-2). Dep. CFSTI.

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C.

A hypercryogenic high-resolution x-ray and γ-ray spectrometer is described. The spectrometer consists of a lithium-drifted germanium detector and a germanium-junction field-effect transistor (JFET) preamplifier. The detector is operated at its optimum temperature, which is in the range of 10–30°K. The JFET's are operated at liquid helium temperature. This results in 0.28 keV FWHM preamplifier resolution with a slope of 0.018 keV/pF. Resolutions of the order of 0.4 keV are obtained with low capacitance detectors for low-energy x rays. The γ rays of ^{57}Co are measured with 0.68 keV FWHM. The described spectrometer was used to study some aspects of the trapping effects in germanium detectors. (auth)

19137 FAST NEUTRON TIME-OF-FLIGHT SPECTROMETER WITH PULSED NEUTRON SOURCE. Seeliger, D.; Pose, H. (Technische Hochschule, Dresden). Kernenergie, 10: 366-8(Dec. 1967). (In German).

A time-of-flight spectrometer for the fast neutrons from T(d,n)

^{4}He reaction with pulsed neutron source is described. Time is measured by means of a time-amplitude converter with time resolution of $2\tau_0 = 10^{-10}$ s for the electric standard signals. The optimum time resolution for monoenergetic light pulses was $2\tau_D = 2 \times 10^{-10}$ s. Intense short neutron pulses are generated by pulsing the ion current of a 150 keV cascade generator using the velocity modulation in connection with the deflection of stationary ion current after acceleration. The width of the neutron peaks in the time-of-flight spectrum and, consequently, the total time resolution of the spectrometer with large-area plastic scintillator is $2\tau = 2.3 \times 10^{-9}$ s. The mean intensity is higher than 10^3 neutrons/4π s. The results obtained for the inelastic scattering of neutrons by ^{12}C have been employed for testing the characteristics of the spectrometer. (auth)

19138 CHARACTERISTICS OF A 85 cm^3 Ge(Li) γ-RAY DETECTOR. Henck, R.; Siffert, P.; Coche, A. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Instrum. Methods, 60: 343-5(Apr. 1968).

Characteristics and performance as a γ-ray spectrometer of a large volume (85 cm^3) two open-ended coaxial Ge(Li) diode are described. By using a low noise field-effect tetrode transistor preamplifier a resolution value of 4.3 keV has been achieved for ^{60}Co (1332 keV). With ^{60}Co and ^{24}Na sources the sum peaks at 2506 keV and 4122 keV have been observed. (auth)

19139 DEPENDENCE OF START PULSE POSITION ON ROTOR SPEED IN NEUTRON TIME-OF-FLIGHT SPECTROMETRY. Salama, M.; Hamouda, I. (Atomic Energy Establishment, Cairo). Nucl. Instrum. Methods, 60: 349-50(Apr. 1968).

The change of start pulse position from an electromagnetic pick-up head with variation of rotor speed in neutron time-of-flight spectrometry can be reduced by using the negative, instead of the positive, swing of the start pulse. (auth)

19140 FINITE SOLID ANGLE CORRECTION FACTORS IN DIRECTIONAL CORRELATION MEASUREMENTS WITH BETA-RAY SPECTROMETERS. Vos, J. W. E.; Van Eijk, C. W. E.; Lewin, W. H. G.; Schutte, F. (Technical Univ., Delft, Netherlands). Nucl. Instrum. Methods, 60: 285-92(Apr. 1968).

Correction factors have been calculated for the attenuation of directional correlation due to the finite solid angle of lens-spectrometers and sector field spectrometers. The factors have been tabulated for angles from 90° to 180° and for entrance diaphragms of different size. The P_2 and P_4 Legendre polynomials are also given for these angles in order to facilitate possible interpolations. (auth)

19141 COMBINATION NEUTRON AND GAMMA RAY SPECTROMETER. Cialella, C. M.; Devanney, J. A. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Nucl. Instrum. Methods, 60: 269-77(Apr. 1968).

An instrument has been developed to measure neutron and gamma ray spectra simultaneously in a mixed radiation field. The method utilizes a single stilbene scintillation crystal with a pulse-shape discrimination circuit. The system routes pulses due to electrons to one output and those due to protons to another output. The spectra are then independently accumulated and analyzed. The response of the spectrometer to neutrons and gamma rays is included. The gamma ray efficiency of the stilbene crystal (1½" dia. × 1½" high) varied from approximately 20% at 1 MeV down to 7% at 10 MeV (counts per incident particle). The gamma ray resolution of the complete spectrometer system, including unfolding, is 31% at 0.322 MeV and 14% at 1.84 MeV. The neutron efficiency of the crystal varied from approximately 48% at 1 MeV down to 13% at 10 MeV (counts per incident particle). The neutron resolution of the spectrometer is 17.4% at 2.0 MeV and 5.2% at 15.5 MeV. Measured neutron and gamma ray spectra from a Pu–Be neutron source are presented. The total neutron output of the source, measured by the National Bureau of Standards, is 1.00×10^7 n/sec. The output measured with the stilbene spectrometer is 1.09×10^7 n/sec. The agreement is within 10%. (auth)

19142 DETERMINATION OF THE NATURAL RADIOCARBON β-ACTIVITY WITH THE LIQUID SCINTILLATION TECHNIQUES. Luyanas, V. Yu.; Shuliya, K. S.; Kibilda, Z. A. (Inst. of Geology, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Moksl u Akad., Liet. TSR Aukst. Mokyklos, 7: 231-43(1967). (In Russian).

The equipment described for natural ^{14}C β-activity consists of two scintillation counters working in coincidence. The activity of radiocarbon is involved in the molecule of methanol. The liquid scintillator is composed of 5 cc methanol, 45 cc toluene, 4 g/l p-terphenyl and 0.1 g/l 1,4-di [2-(5-phenyloxazolyl)]-benzene. The scintillator's cell and two multipliers are shielding with iron (20 cm), lead (20 cm), copper (1,5 cm) and mercury (4 cm). The counting rate of contemporary carbon is 11,61 ∓ 0,12 cpm, when the counting rate of background is 7,81 ∓ 0,07 cpm. The maximum age of this method using 48-hours counting period, on 4δ basis, is determined to be 32300 years. (auth)

19143 SPOTTING URANIUM FROM THE AIR. Stubbs, Peter. New Sci., 37: 592-3(Mar. 14, 1968).

The design of gamma scintillation spectrometers which can be used for aerial surveying for uranium is described. Sodium iodide scintillators distinguish between uranium, thorium, and potassium gamma spectra. (W.H.K.)

19144 NEUTRON SPECTROMETER EMPLOYING CHARGED-PARTICLE COLLIMATION TO IMPROVE RESOLUTION. Wolfe, R. A. (Mound Lab., Miamisburg, Ohio); Stubbins, W. F. Contract AT(33-1)-Gen-53. Nucl. Instrum. Methods, 60: 246-52 (Apr. 1968).

Two different experimental neutron spectrometers were developed using charged-particle collimation to improve the energy resolution in neutron detection by solid-state detectors. The thick spectrometer containing a ^{6}Li metal target, 1.02×10^{-2} cm thick, and two copper collimators showed the neutron energy resolution of approximately 1.5% when detecting 14.7 MeV neutrons. The thin spectrometer containing a 6.0×10^{-3} cm thick ^{6}LiF target and a single collimator was tested with thermal neutrons. The use of charged-particle collimation provided a significant improvement of about 30% in detector resolution for thermal neutrons, although the counting efficiency was reduced to about 85% of that efficiency before collimation. Both spectrometers were maintained under a vacuum to prevent oxidation of the lithium metal and to eliminate the energy loss by the charged particles colliding with gas while traversing the collimators. This study revealed that by separating the two silicon surface-barrier detectors, charged-particle collimation is achieved. The separation provides an alternate means of improving the energy resolution of neutron spectrometers. (auth)

19145 SELECTION OF OPTIMUM MEASUREMENT CONDITIONS IN GAMMA-SPECTROMETRIC FIELD DETERMINATIONS OF RADIOACTIVE ELEMENTS. Saturin, A. A. Vestn. Leningrad. Univ., Ser. Geol. Geogr., No. 24, 68-74(Dec. 1967). (In Russian).

The principles of gamma spectrometry are outlined, and optimum measurement conditions are discussed. An analysis of both the ordinary procedure of gamma-spectrometric field measurements and the suggested one was carried out. The efficiency of the methods is compared. (auth)

19146 NEUTRON SPECTROMETRY BY ACTIVATION DETECTORS. STUDY OF THE METHOD OF SPECTRAL INDICES BY A LINEAR FORMULA FOR CALCULATION OF FLUX. Bricka, M. (Centre d'Etudes Nucleaires, Cadarache, France); Soudain, G. Radioprotection, 1: 15-31(1966). (In French).

A compendious spectrometry of neutrons fluxes is possible by the method of spectra indexes, using activation detectors. The spectra families used are defined by mathematical parametric expressions: $\Phi(E) = a/E \cdot \mathrm{Log}\, E/E_M + 0{,}065/E$ for intermediate energy neutrons, $\Phi(E) = N \cdot E^{\frac{1}{2}} \cdot c^{-\beta E}$ for fast neutrons. Gold, copper, sulphur and magnesium detectors were used. Fluxes can also be obtained with a good approximation by employing linear expressions of detectors activities. The only information from copper and sulphur can estimate the fluxes with an accuracy of twenty percent. The advantages of the proposed spectrometer device are: small dimensions, cheap cost and easy use. (auth)

19147 IMPROVEMENT OF THE RESOLUTION AND TRANSMISSION OF A TOROID-SECTOR TYPE BETA SPECTROMETER. Berenyi, D.; Varga, D.; Buday, I.; Varga, L.; Szalay, A. (Inst. of Nuclear Research, Debrecen, Hungary). J. Phys. E, 1: 364-5 (Mar. 1968).

A conical baffle carrying a non-regular slit, shaped to fit the different focus spots of the individual gaps on the conical surface, was used to improve the parameters of the spectrometer. As optimal figures, 1.5% resolution at 2.1% transmission or 2.3% resolution at 3.9% transmission were obtained. (auth) (UK)

19148 TECHNIQUES OF LOW ENERGY X-RAY AND ELECTRON PHYSICS: 50 TO 1000 eV REGION. Henke, Burton L. (Pomona Coll., Claremont, Calif.). Norelco Rep., 14: 75-83; 98(July-Dec. 1967).

Methods and instrumentation used for research in low energy x-ray and electron physics are reviewed. Spectroscopy in the 10 to 150 Å region by simple adaptations of a commercial vacuum spectrograph is described. A proportional counter was developed for intensity measurements in which pulse-height distribution for

photons of energy as low as 100 eV could be brought out of the electronic noise pulse levels. Development of multilayer systems for long wavelength x-ray analyzers resulted in a new tank design. The building up of multiple layer systems is accomplished by a fatty acid such as stearic acid in n-hexane being spread over a clean substrate of water which contains a small amount of lead ions. This monomolecular layer is compressed and dipped out on mica sheets. Lead laurate, lead stearate, lead lignocerate, and lead melissate provide 2d-spacings 70, 100, 130, and 160 Å respectively. Solar x-ray measurements were made using these mica sheets. It was demonstrated that the spectroscopic system described can yield fluorescence analysis sensitivities for the light elements Mg through Be in the range 0.005% to 0.5%. Photoelectric cross sections were measured for the gas state of the light elements or of their compounds including H_2, CH_4, C_2H_6, N_2, O_2, C_2F_6, H_2S, CCl_4, Ne, Ar, Kr, and Xe, and for 11 characteristic wavelengths in the 8 to 115 Å region. Spectroscopy of electron-excited ultrasoft x radiations is also considered. (BBB)

19149 ON THE STUDY, BY THE SUM AND COINCIDENCE METHOD, OF γ TRANSITIONS IN CASCADE BY MEANS OF A SPECTROMETER USING A GERMANIUM n-i-p DIODE AS DETECTOR. Forest, Hugues; Huguet, Michel (Faculte des Sciences, Nice). Compt. Rend., Ser. A and B, 265: 1204-8 (Nov. 20, 1967). (In French)

A spectrometer for the study of the γ radiation by the Hoogenboom method was developed by associating a semiconductor detector and a scintillator. The method is illustrated on ^{60}Co. (tr-auth)

19150 CHARGED PARTICLE TRANSMISSION THROUGH CYLINDRICAL PLATE ELECTROSTATIC ANALYZERS. Theodoridis, G. C.; Paolini, F. R. (American Science and Engineering, Cambridge, Mass.). Rev. Sci. Instrum., 39: 326-30(Mar. 1968).

The transmission characteristics of cylindrical plate electrostatic analyzers are derived by applying the results of a previous study on the spherical plate analyzer. A transmission matrix is derived for the cylindrical analyzer; coordinates of the matrix are energy and angle of incidence, and the elements are percentage transmission for broad beams of particles. Comparison with a spherical analyzer shows that resolutions (full width half maximum angular and energy responses) are not much different, although peak transmissions are greater by almost 40% for the spherical analyzer. Angle and energy response functions are symmetric for the cylindrical analyzer; in particular, this analyzer has a long high energy tail. Energy-angle factors are calculated from transmission matrices and are essentially identical for the two species of analyzer. (auth)

19151 RESOLUTION OF THREE-CRYSTAL-NaJ-PAIR-SPECTROMETERS AND OPTIMISATION. Hofmann, M.; Taufenbach, H. J. Atomkernenergie, 13: 144-8(1968). (In German).

The resolution function of NaI Pairspectrometers is shown for the optimal case, and it is discussed why the resolution becomes worse at high γ-energies. Experimental results given show that effects disturbing the optimal resolution can be suppressed up to energies of at least 10 MeV. (auth)

High Energy Physics Instrumentation

Refer also to abstract 20153.

19152 SWITCHING OF CLEARING FIELDS ON SPARK CHAMBERS. Sabersky, A. P. (Stanford Univ., Calif.). Nucl. Instrum. Methods, 60: 356(Apr. 1968).

A system for applying clearing-field voltage to the plates of a spark chamber without use of an extra wire or connection is described. (auth)

19153 TRACK FOLLOWING COMPUTER SYSTEM. Kontos, J. (Democritos Nuclear Research Centre, Athens). Nucl. Instrum. Methods, 60: 301-7(Apr. 1968).

A track following computer system is described based on a special purpose computer of novel design. The computing unit of the computer consists of a set of counters and controls a scanner and a mask generator. An element detector signals to the computer the coincidence of a line mask with a track element. The system fits a sequence of line masks to every track in the picture scanned by the scanner. A model system was built, tested and performed satisfactorily. (auth)

19154 PROBLEMS ENCOUNTERED IN COUPLING A COMPUTER TO HIGH ENERGY PHYSICS EXPERIMENTS AT SATURNE. Blanca; Carriere; Forzani; Curel; Katz; Monet; Rondele; Segalas Bull. Inform. Sci. Tech. (Paris), No. 121, 7-31(Dec. 1967). (In French).

A distribution of the different functions to be assigned to the computer is proposed and means employed to accomplish this program are discussed. The CAE 9040 computer chosen is first presented with its standard equipment and its acquistion and exchange equipment specific to real time functioning. A number of problems dealing with interface equipment at present being studied by the CEN/S are mentioned (transmission and sequential data presentation, systems, exploitation panel...). Finally, the programming of such a unit forms the subject of a special study on some of the awkward problems arising from the use of the computer in real time. The use of a management supervisor is proposed. (auth)

19155 "SAGE": USE OF A COMPUTER IN A HIGH-ENERGY EXPERIMENT. Brisson, J. C. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 121, 33-39(Dec. 1967). (In French).

In view of the volume of data to be processed, a computer was included in the equipment used for an experiment involving hodoscopes and spark chambers (wire and ferrite core type). Although logic decisions are determined by hardware (for the sake of rapidity), the experiment is controlled by the computer, each detector being treated as a peripheral unit. Changes in the experimental process are greatly facilitated, since they simply correspond to a program modification. (auth)

19156 THE SEALING OF ILLUMINATORS OF LARGE HYDROGEN BUBBLE CHAMBERS. Lebedev, R. M.; Saitov, I. S.; Ustenko, E. P.; Shishov, Yu. A. (Joint Inst. for Nuclear Studies, Dubna, USSR). Cryogenics, 7: 302(Oct. 1967).

A description is given of a new arrangement for sealing large glass illuminators in hydrogen bubble chambers, using the flexible surface of the pneumatic element for sealing the liquid hydrogen. (UK)

19157 TELECENTRIC CAMERA LENS FOR BUBBLE CHAMBER PHOTOGRAPHY. Carnell, K. H. (Imperial Coll. of Science and Tech., London); Gortmans, N. C.; Welford, W. T.; Pataky, C. Opt. Acta, 15: 187-93(Mar.-Apr. 1968).

A 127 mm, F/25, 54° telecentric objective has been designed and fabricated for use with the 80 cm liquid helium bubble chamber of the Rutherford High Energy Laboratory. (auth) (UK)

19158 METHOD AND DEVICE FOR PRODUCING A HIGH-SPEED RECIPROCATING MOVEMENT, IN PARTICULAR FOR BUBBLE CHAMBERS. Beauval, Jean-Jacques; Duhem, Jean; Pacchioni, Antenore (to Commissariat a l'Energie Atomique). British Patent 1,105,196. Mar. 6, 1968. Priority date Nov. 17, 1965, France.

Two gas-filled chambers are separated by a moving piston which uses the pressure difference in the two chambers to aid its reciprocating motion. The stroke and frequency of the piston is regulated by latching systems at the extreme positions of the piston during a cycle. (W.H.K.)

19159 DEVICE FOR TRIGGERING GAS DETECTOR OF NUCLEAR PARTICLE. Lansiart, A.; Leloup, J.; Lequais, J. (to Commissariat a l'Energie Atomique). Canadian Patent 777,282. Jan. 30, 1968. Priority date June 11, 1963, France.

A gas-filled spark chamber contains an anode and cathode energized by a dc potential. Electron pulses caused when passing nuclear particles ionize the gas are amplified. A generator, responsive to such amplified pulses, applies a high voltage to the cathode so that a spark delineates the path of the moving particle. A suitable circuit, also responsive to the amplified pulses, blocks the amplifier during a predetermined dead time of the spark chamber. A discriminator is also included to block all output pulses from the amplifier which do not fall within a predetermined range of values. A time delay circuit is connected between the discriminator and the generator. The photocathode has crystal of NaI activated with Tl mounted against it. (F.S.A.)

Radiation Dosimeters

19160 (NYO-3409-4) THE ROLE OF TRAPPING PROCESSES IN SOLID STATE RADIATION DOSIMETRY. Progress Report Covering the Work Done to Date. Henisch, Heinz K. (Pennsylvania State Univ., University Park. Materials Research Lab.). Feb. 1968. Contract AT(30-1)-3409. 33p. Dep. CFSTI.

A summary of research on solid state radiation dosimetry is presented. The possibility of utilizing the pyroelectricity of tourmaline for x-ray dosimetry is discussed. The use of neutron-irradiated diamonds for uv dosimetry is described. Current-glow measurements of diamonds, obtained by thermal stimulation after uv exposure, are analyzed. Ultraviolet dosimetry using pyroelectric zinc sulfide is considered. Also, thermoluminescent dosimetry of ultraviolet radiation using bismuth-doped zinc sulfide is examined. (W.H.K.)

19161 (SZS-2/68) ZWEI EINFACHE NEUTRONENSTRAHLUNGSMESSGERAETE FUER DIE STRAHLENSCHUTZPRAXIS. (Two Simple Neutron Detectors for Radiation Protection Use). Kiesewetter, W.; Steuer, J. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Jan. 1968. 39p. (In German). Dep.

Two neutron rate meters for radiation monitoring in working areas are described. The devices allow a reading in units of dose-equivalent rates for a wide neutron energy range and possess a good discrimination of gamma-radiation. The two ratemeters have been constructed on the basis of commercially available gamma-dose rate meters (Curiemeter VA-J-10 and SRP 2 Kristall). As detectors a BF_3-counter tube and a B_2O_3– ZnS(Ag)-scintillator in DePangher double-moderator technique arrangement are used. Some experimental data are reported. (auth)

19162 (NSJ-tr-99) CHARACTERISTICS OF A FLUORITE THERMOLUMINESCENT DOSIMETER WITH CHARGE-SENSITIVE AMPLIFIER. Nakajima, Toshiyuki; Hashizume, Tadashi. Translated from Oyo Butsuri, 35: 870-5(Dec. 1966). 14p. Dep. JCL $1.60 fs, $0.80 mf.

The characteristics of a thermoluminescent dosimeter of fluorite crystals were investigated by a method in which a charge-sensitive amplifier was used. The reading system of this method is to integrate the intensity of emission glow under the required peaks. The data for zinc fluoride doped with manganese and for lithium fluoride were obtained as the basic data of thermoluminescence dosimetry covering the range of x-ray exposure dose from 10^{-1} to 10^{3} roentgen. (auth)

19163 A NEUTRON-DOSIMETER AND ITS USE IN THE NEUTRON-FIELD NEAR THE REACTOR TRIGA MARK II. Tschirf, E. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Atomkernenergie, 13: 139-43(1968). (In German).

A new neutron-dosimeter on activation base for simple and prompt measurement of the personal-Rem-dose is described. The result of the measurements shows that it does not depend on the form of the neutron spectrum and that doses under 300 mRem can be measured. (auth)

19164 SENSITIVE BUNCHED GAMMA CALORIMETER. Handl, Josef (Inst. of Nuclear Research, Prague). Jad. Energ., 14: 110-12(Mar. 1968). (In Czech).

Construction and results of electrical power calibration of thermistor semiadiabatic calorimeter with one lead absorber are described. This calorimeter is designed for standardization measurements of ^{60}Co gamma ray beams and sensitivity obtained (3.17×10^{-2} deg/J) allowed measuring ^{60}Co gamma beam powers from 0.1 mW and with accuracy up to 2 percent. (auth)

19165 MEASUREMENT OF INDIVIDUAL DOSES IN MIXED RADIATION FIELDS OF UNKNOWN COMPOSITION BY USING MULTICOMPONENT DOSIMETER SYSTEMS. Rothe, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Kernenergie, 10: 368-72(Dec. 1967). (In German).

A compensation method for individual dose measurement in mixed radiation fields of unknown composition is described. The dose may be determined by means of simple formulas. The method therefore is suitable for the automatic evaluation of the dosimeters. The method is described theoretically and is analyzed. Aspects of the selection of the components for the film badges for mixed x-, γ- and β-radiations are discussed and applied to the new individual dosimeter used in the G.D.R. In evaluating the film badges, the energy dependence amounts to -40% + 50% for 12 keV to 2 MeV quantum energy and to -30% + 100% for maximum β-energies of 0.4 to 3 MeV. (auth)

19166 FOURIER ANALYSIS OF THE BLURRING CAUSED BY THE IONIZATION CHAMBER. III. CONCERNING ENERGY DEPENDENCY. Uchida, Suguru (Osaka Univ.). Jap. J. Appl. Phys., 7: 306-7(Mar. 1968).

The spatial frequency characteristics of a 4 mm diameter ionization chamber for cobalt-60 gamma dosimetry in air and in depth and the real air and depth dose distributions on the collimated field are presented. (W.H.K.)

19167 NOTES ON THE CONCEPT OF THE "PREDOSE" IN RADIOPHOTOLUMINESCENCE DOSIMETRY. Delarue, R.; Carpentier, S.; Francois, H.; Chapuis, A. M. (Carbonisation Entreprise et Ceramique, Montrouge, France. Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Atompraxis, 14: 30-2(Jan. 1968). (In French).

The predose concept in radiophotoluminescence dosimetry does not correspond to any physical property of the composition of the glass. Rather, it is a practical property which depends not only on the composition of the glass, but also upon its shape and the type of evaluation equipment used. The concept is significant only for stable and usable glasses. This requirement is met by the glasses of the Lumidosimeter System C.E.A. Predose is defined in the following formula: Predose P [Roentgen] = Basic Signal F [Microampere]/Sensitivity S [Microampere/Roentgen]. The influence of the shape of the Lumidosimeter glasses and the evaluation equipment is shown in 2 tables. It is concluded that the Lumidosimeter glasses type MB and SC, if used together with an evaluation device especially constructed for these glasses, make it possible to measure sensitivities of a magnitude of 100 to 200 mR. (auth)

19168 PERSONNEL NEUTRON DOSIMETER FOR NUCLEAR ACCIDENT. Kang, Yung-Ho (Kyung Pook National Univ., Taegu, Korea); Tatsuta, Hatsumi. J. Nucl. Sci. Technol. (Tokyo), 5: 74-8(Feb. 1968).

Two types of personnel dosimeter are presented: an emulsion containing ^{10}B and a Toshiba glass-covered model embodying natural uranium foil. If a Cd sheet is used to reduce thermal neutrons leaving the human body, measurements of the dose equivalent will be possible to cover a neutron energy range between thermal and 10 MeV. Experimental results show that the minimum detectable dose equivalent with the dosimeters are 0.15 rem and 10 rem for the emulsion type and the etched pit type, respectively. (auth)

19169 PHOTOSENSITIVITY OF CLEAR PERSPEX DOSIMETERS. Orton, C. G. (New York Univ., N. Y.). Int. J. Appl. Radiat. Isotop., 19: 297-8(Mar. 1968).

Comments are made on a paper by Whittaker and Lowe (loc. cit. 18: 89 (1967)) in which an investigation of the effects of the uv component of sunlight on irradiated clear Perspex dosimeters is reported. The reverse fading reported by these authors is considered not to be a new phenomenon, but a spontaneous phenomenon which is usually masked by oxygen diffusion. The substantial reverse fading due to exposure to uv can be eliminated either by making the time lapse between irradiation and measurement short (1 hr or less), or by keeping the dosimeters in light-tight containers after exposure. Factors involved in the fading process are briefly discussed. (UK)

19170 PHOTOGRAPHIC DOSIMETRY OF γ RAYS WITH THE FD-I DOSIMETER. Gizea, F.; Nicolae, Marieta (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 963-72(1967).

Some characteristics of the ORWO 3 and ORWO 4 dosimetric films and of the Fd-I photodosimeter, currently used at IFA and in other nuclear units for personnel doses determination are investigated. The sensitivity dependence on energy, the superior and inferior limit doses, conservability, fogging variation with the time, fading speed for the emulsions ORWO 3 and 4 and the method of doses determination are reported. It is concluded that the film ORWO 3 is apt for current dose evaluation between 15 mR and 5 R, while ORWO 4 allows measurement of doses at accidental exposure, from 500 mR to 100 R. (auth)

19171 CALORIMETRIC DETERMINATION OF THE G-VALUE OF THE FERROUS SULPHATE DOSIMETER WITH HIGH-ENERGY ELECTRONS AND ^{60}Co GAMMA-RAYS. Pettersson, C. (Univ. of Umea, Sweden). Ark. Fys., 34: 385-400(1967).

A calorimeter that measures radiation energy absorption in water by means of the volume expansion caused by the temperature rise during irradiation is described. The calorimeter consists of a spherical Dewar flask about 12 cm in diameter. A temperature stabilized water bath serves both as a quasi adiabatic shield and as a phantom around the Dewar flask. The volume expansion was measured with accurately calibrated capillaries, which were connected to the Dewar flask. At a mean dose rate of 200 Rad/min the reproducibility was better than 0.5% when doses of the magnitude of 3000 Rad were measured. By means of the calorimeter, G-values were determined for the ferrous sulfate dosimeter (1 mM ferrous ammonium sulfate, 1 mM sodium chloride in 0.8, and 0.1 N sulfuric acid respectively) with high-energy electrons of an estimated primary mean energy of approximately 20 MeV and with ^{60}Co gamma-rays. At the G-value determinations the dosimeter solution was irradiated in the calorimeter volume in a geometry identical with that at the calorimeter runs. (auth) (Sweden)

19172 IMPROVED DOSIMETER GLASS WASHING TECHNIQUE. Yokota, Ryosuke; Muto, Yuhei (Tokyo Shibaura Electric Co., Ltd.). J. Nucl. Sci. Technol. (Tokyo), 5: 35-6(Jan. 1968).

A technique for washing glass for silver-activated phosphate glass dosimeters is described. The glass is washed in a weakly alkaline liquid detergent, then tap water, then distilled water, and then rinsed twice in reagent grade ethanol. A special tray and supersonic washer is used. (W.H.K.)

19173 NEUTRON FILM DOSIMETER USING MULTIPLE FILTERS. Kocher, Leo F. (to United States Atomic Energy Commission). U. S. Patent 3,372,275. Mar. 5, 1968.

A film badge which measures the fast neutron dose and the slow neutron dose in the presence of alpha, beta and gamma radiation is described. The badge utilizes three filters which are opaque to alpha and beta radiation and which have equal absorption of photons. Each filter responds in a different manner to neutrons. The fast neutron dose and the thermal neutron dose can be calculated. (AEC)

Radiometric Instruments

Refer also to abstracts 18941 and 19081.

19174 NOTE ON THE CLEANING OF THE ^{63}Ni ELECTRON CAPTURE DETECTOR. Williams, I. H. (Dept. of Agriculture, Vancouver, Can.). J. Ass. Offic. Anal. Chem., 51: 64 (Jan. 1968).

A method is described for cleaning a ^{63}Ni electron capture detector used for pesticide residue analysis. Contamination has caused an appreciable decrease in detector sensitivity and sometimes frequent and persistent spiking. The method used is injection of three or four 100 μl portions of water through the empty column and detector (if necessary more can be used). In the system the water is heated to 300°C and the superheated steam quickly restores the background current to its normal value and eliminates the spiking. (B.G.D.)

19175 MERCURY POROSIMETER USING ABSORPTION OF GAMMA RADIATION FROM A ^{137}Cs SOURCE. PORE'S SPECTRA OF HETEROGENEOUS MATERIALS. Ortega, M.; Teoule, R. (Centre d'Etudes Nucleaires, Grenoble, France). Bull. Soc. Chim. Fr., No. 1, 130-4(Jan. 1968). (In French).

A new mercury porosimeter is described using absorption of gamma radiation from a Cs 137 source for measuring the volume of the infiltrated mercury. This apparatus permits the investigation of a very wide range of equivalent pore radii. At low pressures, with a collimated beam, the mercury column is rigorously defined. At high pressures, the measurement of the infiltrated volume is not sensitive to the deformations of the valves, gaskets and even leaks of mercury. Moreover, for heterogeneous samples, it is possible to determine simultaneously the pore spectra corresponding to different regions. (auth)

19176 APPLICATIONS OF THE MERCURY POROSIMETER USING GAMMA RADIATION TO PORE'S SPECTRA LOCALISED MEASUREMENT OF HETEROGENEOUS CARBON SAMPLES. Teoule, R.; Ortega, M.; Bochirol, L. (Centre d'Etudes Nucleaires, Grenoble, France). Bull. Soc. Chim. Fr., No. 1, 134-8 (Jan. 1968). (In French).

Some examples of the use of a gamma absorption porosimeter described in a previous paper are reported. The study of transformations inside the porous mass of a carbon sample subjected to oxidation reactions in air and densification by craking of natural gas is discussed. (auth)

19177 UNIVERSAL HOSE GAMMA DEFECTOSCOPE WITH REMOTE CONTROL TRANSPORTER. Sul'kin, A. G.; Kuleshov, A. V.; Maiorov, A. N. Defektoskopiya, No. 6, 55-60(1967). (In Russian).

The γ defectoscope RID-21, a universal apparatus of the hose type with magazine container, was described. In the assembly ^{192}Ir, ^{137}Cs, and ^{170}Te can be used in the head. (J.S.R.)

19178 PERFORMANCE OF NUCLEAR-SEDIMENT CONCENTRATION GAGES. McHenry, J. R.; Coleman, N. L.; Willis, J. C.; Murphree, C. E.; Bolton, G. C.; Sansom, O. W.; Gill, A. C. (U. S. Dept. of Agriculture, Oxford, Miss.). pp 207-25 of Isotopes in Hydrology. Vienna, International Atomic Energy Agency, 1967.

From Conference on Isotopes in Hydrology, Vienna. See STI/PUB-141; CONF-661133.

Three sediment concentration gages, utilizing the attenuation of transmitted gamma rays as a measure of density, were compared in laboratory tests. Two of the gages used ^{109}Cd as the radioactive source and one employed ^{241}Am. The effects of each probe on stream velocity and sediment concentration gradients within the sampling area were considered. The precision and accuracy of the laboratory measurements were calculated and calibration curves were obtained under both static and dynamic conditions. A minimum detectable sediment concentration of less than 500 ppM was obtained with the ^{241}Am gage. The ^{109}Cd gage developed for remote, unattended, automatic operation was the least sensitive to small changes in sediment concentration. The gages using ^{109}Cd were tested under field conditions. The performance of the automated ^{109}Cd gage was evaluated in terms of conventional sediment sampling. Interpretation of a single-point concentration of sediment is different from that of an integrated sample. Much more field data must be collected and examined before the data obtained with either of these gages can be expressed as sediment yield. Each of the three gages is designed for a particular application. Each gage performs best under certain conditions. In their present state of development, these nuclear-sediment concentration gages supplement rather than compete in their use and performance. Each gage will provide the hydrologist with information not now obtainable by conventional means or will provide more information at a lower expenditure than is now possible. (auth)

19179 APPARATUS FOR THE DEPOSITION OF A SENSITIVE EMULSION FOR AUTORADIOGRAPHS. Cornue, Maurice; Khau-Van-Kien, Louis (to Commissariat a l'Energie Atomique). British Patent 1,104,834. Feb. 28, 1968. Priority date Nov. 26, 1965, France.

An apparatus for automatically depositing and spreading with rollers an emulsion on plate holders for autoradiographic uses is described. The equipment is contained in an optically sealed chamber whose temperature and atmospheric conditions can be controlled. (W.H.K.)

19180 FILAMENT THICKNESS MEASURING BY MEANS OF BACK SCATTERED BETA RAYS. Fries, Bernard A. (to Chevron Research Co.). U. S. Patent 3,364,354. Filed Mar. 24, 1964.

A radiometric system for measuring the weight per unit length of a filament traveling between two points along a central axis is described. The path of said filament is substantially fixed in location relative to said axis in a first direction, while the location of said path relative to said axis in a second direction normal to said first direction is variable within limits. It is composed of a source of beta particles, collimating means located between said filament and said source, and means for detecting and counting beta particles from said source intercepting said filament and backscattered from said filament to determine said weight per unit length. (U. S. Pat. Gazette)

19181 IMPROVEMENTS RELATING TO ANALYSIS CELL WINDOW ASSEMBLIES. Starnes, Peter Edward (to Hilger and Watts Ltd.). British Patent 1,103,563. Feb. 14, 1968. Filed Apr. 2, 1965.

The manufacturing method consists of forming a sheet of bi-directionally stretched and heatset polyethylene terephthalate into the required shape under the influence of heat and pressure in such a manner that the area of film which constitutes the effective window aperture is substantially unchanged in thickness during the forming operation. Also, the film is subjected to a hydraulic stretching operation to stabilize it against creeping. (W.H.K.)

Miscellaneous Instruments and Components

Refer also to abstracts 18953, 18957, 19155, 19468, and 20904.

19182 (AAEC/M-77) PORTABLE RATEMETER AAEC TYPE 239: SERVICE MANUAL. Fraser, H. J.; Church, V. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aug. 1967. 23p. Dep.

The portable transistorized ratemeter AAEC Type 239 was designed for accurate field measurements with radioactive isotopes. It consumes 0.2W either from batteries or from a mains operated power pack, and has a total weight of 11 lb. EHT voltages for polarizing a scintillation counter or Geiger-Mueller tube are available in steps of 50V over the range 300V–145V. The instrument covers 0-10,000 counts per second in seven linear ranges. The indicated count rate does not deviate by more than ±3% for a battery input of 4.5V to 7V or for an ambient temperature of 0°C to 60°C. A window discriminator is provided so that the ratemeter can be used as a single channel pulse height analyzer by varying amplifier gain. The ratemeter is described and details are given of its operation and maintenance. The ratemeter was designed in the General Physics Section of the AAEC General Nucleonics Division. (auth)

19183 (ANL-7386) MOESSBAUER-EFFECT DATA-COLLECTION SYSTEM. Vonderohe, R. H.; Aschenbrenner, R. A. (Argonne National Lab., Ill.). Nov. 1967. Contract W-31-109-eng-38. 18p. Dep. CFSTI.

A system is described which has several advantages over running the same number of experiments, each with a dedicated analyzer. First, the cost of the computer system is approximately

30% less than the cost of four analyzers. In spite of this price differential, there is no loss of versatility to the experimenter (assuming, of course, there is no catastrophic failure). In fact, the computer system offers a great deal more versatility, particularly in the area of data preprocessing. It is now possible to do such things as channel summations, spectra folding, and exact peak center determinations, which were previously unrealizable with analyzers. In addition, the energy calculations that previously required additional computing power may now be performed. Another advantage of this system is the capability of outputting an experiment and reloading the same experiment at a later time for additional data storage. In short, the system has all the advantages of a general-purpose digital computer in addition to performing the tasks of a wired-program analyzer. (auth)

19184 (BARC–310) CURRENT INTEGRATOR FOR USE WITH LOW VARIABLE CURRENTS. Gupta, S. K. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 8p. Dep.

A transistorized current integrator using a very high input impedance was designed. It is found to be linear in the range 1 nA to 10 μA. The leakage was reduced to $\sim 5 \times 10^{-12}$ A and reproducibility of the calibration is less than ±0.3%. (auth)

19185 (BNWL–SA–1391) RECENT DEVELOPMENTS IN THE DETECTION OF HEAVY METALS IN TISSUE. Bramson, P. E.; Brown, R. L. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 14, 1968. Contract AT(45-1)-1830. 14p. (CONF-680302–3). Dep. CFSTI.

From International Symposium on Nuclear Electronics and Radioprotection, Toulouse, France.

The location of plutonium within a contaminated wound is often difficult to determine giving rise to a situation in which the surgeon may not know how large an excision is necessary to remove all of the contaminant. The result is that a dispersion of the contaminant in the tissue may occur necessitating more extensive excision than would have been needed if the location could have been more closely determined. Accurate location of plutonium or other heavy metal particles within tissue is, therefore, a necessity for efficient excision. A previously reported method for defining the depth of plutonium in wounds uses the relative attenuation ratio of the 13 and 20 keV x-rays of plutonium-239. Lithium-drifted silicon detectors are employed to resolve the two x-rays. The relative counting rates of these two photons define the depth of a point source or the average depth of multiple sources in a wound due to the fact that tissue attenuation of the 13 keV x-ray is four times greater than the 20 keV x-ray. The relative attenuation method is hampered by the x-ray absorption by any plutonium or other foreign material which may be in the wound. An electromagnetic (eddy current) sensing device is being developed for locating heavy metal particles in human tissue. A probe has been designed and fabricated which is capable of both wide area search and pinpoint accuracy. This device is able to detect tiny plutonium particles embedded in tissue equivalent material and it is possible, using this technique, to locate the particle in two dimensions and to obtain an indication of its depth in tissue. Since this method does not depend upon determining the relative intensity of characteristic radiation, it is also applicable to the detection of non-radioactive electromagnetic conductors embedded in tissue. Applicability of ultrasonic detection techniques was also considered. This method is potentially very sensitive but is limited, in this application, by interfering signals if the particle is in close proximity to bone. The usefulness may be further reduced since power levels must be limited to avoid tissue damage. (auth)

19186 (EGG–1183–428) TECHNIQUE FOR RADIATING AN ISOLATED PULSE OF ELECTROMAGNETIC FIELD. Technical Report Number B-3719. Fitzgerald, C. S. (EG and G, Inc., Boston, Mass. Eastern Science and Technology Div.). Dec. 27, 1967. Contract AT(29-1)-1183. 58p. Dep. CFSTI.

This waveform is produced to calibrate extremely broadband systems for measuring electromagnetic fields. The technique involves the generation of a traveling wave on a vertical cone antenna joined at its extreme ends by a horizontal, open wire transmission line. Analytical predictions are compared with experimental results. (W.H.K.)

19187 (IS–1740) THE DESIGN, INSTALLATION, AND OPERATION OF AN AUTOMATIC NEUTRON DIFFRACTION SYSTEM. Dahm, D. J.; Jacobson, R. A. (Ames Lab., Iowa). Dec. 1967. Contract W-7405-eng-82. 28p. Dep. CFSTI.

A Hilger-Watts four circle neutron diffractometer operates under the control of an SDS 910 computer. The interfacing and programming for the system are of local origin. A neutron beam forming an angle of 90° with the incident beam is taken from the beryllium monochromating crystal located inside the reactor face. Alignment of the diffractometer, both optically and with neutrons, the neutron detection devices, and other aspects of the system are discussed in some detail. (auth)

19188 (JINR–P8–3679) ELEKTRONNAYA LOGICHESKAYA SISTEMA DLYA UPRAVLENIYA DROSSEL'NOI OZHIZHITEL'-NOI USTANOVKOI S TSIRKU LYATSIONNYM TSIKLOM. (Electronic Logic System for Control of the Linde Liquefier With a Circulating Cycle). Sikolenko, V. F.; Tishchenko, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 13p. (In Russian). Dep.

An electronic logic system for control of the Linde liquefier with a circulating cycle has been described. The application of this system allows to automatize the most part of the technological process of gas liquefaction. The similar system of automatic control can be used in other cases requiring regulation of the pressure and the quantities of gas and liquids transferred. (auth)

19189 (NP–17362) ON THE THEORY OF THE DIOCOTRON INSTABILITY: A SERIES DEVELOPMENT METHOD. Rijnhuizen Report 67-41. Schuurman, W. (Stichting voor Fundamenteel Onderzoek Der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Aug. 1967. 13p. Dep.

The long wavelength diocotron instability is analyzed theoretically in rectangular geometry by means of a series expansion in $\epsilon = \omega_p^2/\omega_c^2$. Within the convergence region results of existing theories for either $\epsilon \ll 1$ or $\epsilon \approx 1$ are found back. The mathematical tools are not complex, so that it may be expected that new effects, e.g., a magnetic field gradient, a non-zero temperature, can be built into the theory. (auth)

19190 (ORNL–TM–1638(Pt.5)) NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART 5. DUAL OPERATIONAL AMPLIFIER, ORNL MODEL Q-2605. Anderson, J. L. (Oak Ridge National Lab., Tenn.). Jan. 30, 1968. Contract W-7405-eng-26. 29p. Dep. CFSTI.

The circuit, applications, maintenance procedures, and acceptance tests for a Dual Operational Amplifier, ORNL Model Q-2605, are described. The amplifier is a commercial design manufactured to ORNL Specification SP-232 by Electronic Associates, Inc., as EAI Model 6.720. The unit consists of two independent high-gain amplifier circuits packaged on an etched circuit board. The circuit is housed in a 1-unit module of the Modular Reactor Instrumentation series Q-2600. Each amplifier can be used in conjunction with appropriate networks to perform linear computations, such as summation, integration, and multiplication by a constant. (auth)

19191 (ORNL–TM–1638(Pt.15)) NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART 15. 0.1 hp DC SERVO AMPLIFIER, ORNL MODEL Q-2615. DeLorenzo, J. T. (Oak Ridge National Lab., Tenn.). Jan. 22, 1968. Contract W-7405-eng-26. 17p. Dep. CFSTI.

The 0.1 hp DC Servo Amplifier is a dc power amplifier which can supply a maximum of 75 W at voltage and current limits of 25 V and 5 amp respectively. The amplifier was designed to drive a Globe Industries, Inc., type BD dc motor with a 27-V armature. In a typical application this motor is used as the servo motor to position a fission chamber in a wide-range counting-rate channel. The signal input voltage swing required for full output is +10 and −10 V. The amplifier is packaged in a standard 3-unit plug-in module of the ORNL modular reactor instrumentation series. The circuit, applications, maintenance procedures, and acceptance tests for the servo amplifier are described. (auth)

19192 (ORNL–TM–1638(Pt.22)) NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART 22. LINEAR COUNT-RATE METER, ORNL MODEL Q-2622. DeLorenzo, J. T. (Oak Ridge National Lab., Tenn.). Jan. 8, 1968. Contract W-7405-eng-26. 25p. Dep. CFSTI.

A linear Count-Rate Meter Module was designed to provide a dc current proportional to the counting rate of input pulses in four switchable ranges. It consists of a flip-flop, limiting amplifier, diode pump driver, and diode pump. The current output of the diode pump feeds directly into the summing junction of an external operational amplifier. The instrument was intended primarily for use in the neutron counting channels of the ORNL High Flux Isotope Reactor. It is packaged in a standard 2-unit plug-in module of the ORNL Modular Reactor Instrumentation series. The circuit, application, maintenance procedures, and acceptance tests for the unit are described. (auth)

19193 (TID–20893(Rev.2)) STANDARD NUCLEAR INSTRUMENT MODULES. Adopted by AEC Committee on Nuclear Instrument Modules. Costrell, Louis (National Bureau of Standards, Washington, D. C.). Jan. 1968. 31p. Dep. GPO $0.25.

Specifications for standard nuclear instrument modules are presented to assure mechanical and electrical interchangeability of modules. Bin and power supply specifications are included. (W.H.K.)

19194 (TID-24284) PLUGGING METER AND CONTINUOUS OXYGEN METER. Mimushkin, B. (United Nuclear Corp., White Plains, N. Y. Development Div.). Apr. 14, 1964. Contract AT(30-1)-2877. 15p. (MTL-3761). Dep. CFSTI.

Two types of on-line impurity meters for liquid sodium cooling systems are discussed. A recent development in the design and use of plugging meters is described. Also, the design of an electrochemical oxygen meter is presented. (W.H.K.)

19195 (UCRL-50344) STUDIES OF A FLUIDIC OSCILLATOR AS A TEMPERATURE SENSOR. Osborne, R. L.; Cooksey, D. D. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 1, 1967. Contract W-7405-eng-48. 27p. Dep. CFSTI.

A fluidic bistable amplifier operating as a control-to-control-port oscillator has been investigated as a temperature sensor. This device offers the advantages of apparently being insensitive to radiation and of being capable of operation at high temperatures limited only by the structural integrity of the fabrication material. Since it operates as a frequency-modulating device, noise problems in data transmission are minimized. The control-to-control-port configuration was used in order to minimize the heat removed from the material whose temperature was being measured. The effects of several process parameters on unit operation were investigated. These included supply pressure to the unit, diameter of the sensing tube and the effects of irregularities in the diameter of the sensing tube. The work showed that a fluidic bistable oscillator can be used as a temperature sensor, operating in the control-to-control-port configuration, provided sufficient attention is paid to the operating parameters and the geometry of the unit. (auth)

19196 (UNC-5131) DEVELOPMENT OF A CONTINUOUS ELECTROCHEMICAL METER FOR OXYGEN IN SODIUM. Minushkin, B.; Kolodney, M. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Dec. 15, 1967. Contract AT(30-1)-2877. 167p. Dep. CFSTI.

A practical on-line instrument developed for continuously measuring the oxygen content of sodium is described. The meter is based on a galvanic cell with a $ThO_2-Y_2O_3$ solid electrolyte and a reversible oxygen Cu, Cu_2O reference electrode. The cell develops a voltage which is dependent on the thermodynamic activity (or effective concentration) of oxygen in the sodium. The oxygen meter consists of three major components: an electrode assembly, a housing, and a voltage indicator. The electrode assembly in contact with sodium forms the galvanic cell. The housing provides the means for exposing the electrode assembly to flowing sodium and also provides a stainless steel containment envelope for the electrode assembly. The voltage indicator measures the cell voltage and provides output signals to operate a recorder and alarms which indicate excessive changes in oxygen content or cell breakage. (W.H.K.)

19197 TECHNIQUE OF THE DETERMINATION OF THE THICKNESS OF THIN FILMS DEPOSITED ON THE LAYER OF SOME OTHER MATERIAL. Voitovetskii, V. K.; Korsunskii, I. L.; Tolmacheva, N. S. (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Instrum. Methods, 60: 284(Apr. 1968).

A method is proposed and experimentally tested, for determination of the thickness of thin films deposited on the layer of some other material by weighing in a liquid whose density is equal to that of the backing. (auth)

19198 QUADRUPOLES, MONOPOLES, AND ION TRAPS. Dawson, P. H.; Whetten, N. R. Res./Develop., 19: 46-50(Feb. 1968).

Mass spectrometers utilizing strong-focusing techniques are described. The quadrupole mass filter, the monopole mass spectrometer, and the three-dimensional quadrupole spectrometer, or ion trap mass spectrometer, are discussed. (W.H.K.)

19199 OSCILLATOR OF VERY HIGH FREQUENCY STABILITY UTILIZING A SUPERCONDUCTING CAVITY. Nguyen Tuong Viet (Faculte des Sciences, Orsay, France). Ann. Phys. (Paris), 2: 225-40(July-Aug. 1967). (In French).

A high-stability oscillator, the frequency of which is tunable over a range around 2911 MHz by utilization of a high-Q superconducting cavity, is described. The latter is associated with a traveling-wave tube amplifier (T. W. T.) and the whole setup constitutes a self-oscillator. The principle and conditions of oscillation are analyzed in detail. The influence on the frequency stability of the following parameters is calculated: Q factor of the cavity, room and liquid helium bath temperatures, power-supply voltage fluctuations, and noise factor of the T. W. T. This shows that the oscillator can have performances as good as those of the best quartz oscillators associated with frequency multipliers. Short term stability due to noise is excellent and can be compared with advantage to that of quartz and atomic clocks. Experimental results show that the S-band oscillator so realized has a stability of 4.5×10^{-11} per minute for an output power of 1 mW and 3.4×10^{-10} for 1 W. Greater stabilities could be obtained by improving the cavity Q factor from 10^3 to 10^4. (auth)

19200 X-RAY COUNTER DIFFRACTOMETER FOR CRYSTAL STRUCTURE INVESTIGATIONS ON NEUTRON IRRADIATED MATERIALS. Dienst, W.; Krautwedel, H. L. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 10: 46-50(Jan. 1968). (In German).

An x-ray interference goniometer for the study of the crystal structure of radioactive specimens is described, designed for a fission products activity up to about 10 Ci. The apparatus was constructed using components of a standard counting tube goniometer. The x rays are deflected by a LiF monochromator. The lead shielding of the counting tube travels together with the monochromator and the counting tube around the goniometer circle. The measurement and evaluation methods are discussed briefly on the example of the x-ray peaks of an irradiated UO_2 specimen. The maximum relative error in determining lattice constants amounts to $\pm 3 \times 10^{-4}$. (auth)

19201 NUCLEAR ELECTRONICS: A PULSE AMPLIFIER AND DIFFERENTIAL DISCRIMINATOR WITH INTEGRATED CIRCUITS. Moll, G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Kerntechnik, 10: 54-5(Jan. 1968). (In German).

Block wiring diagrams are included, and a brief description of the amplifier, including a delay line clipping stage, and the discriminator, which consists of a window amplifier and two Schmitt triggers, is presented. (W.H.K.)

19202 GENERALIZATION OF THE VOLT-AMPERE CHARACTERISTIC OF COAXIAL PLASMATRON WITH MAGNETIC STABILIZATION OF THE ELECTRIC ARC. Kisel, V. S.; Uryukov, B. A.; Yadrov, V. I. Izv. Sib. Otd. Akad. Nauk SSSR, No. 8, Ser. Tekh. Nauk, No. 2, 105-8(June 1967). (In Russian).

The results of the generalization of the volt-ampere characteristics of the coaxial plasmatron with magnetic stabilization of the arc at pressures near atmospheric are reported. The generalization is made on the basis of the theoretical examination of the physical model of the electric arc in the plasmatron and the experimental data, including a wide range of variations of the geometry of the electroarc chamber, of the flow rate of the gas current on the arc, and the intensity of the magnetic field in the region of the existence of the arc. (tr-auth)

19203 DETAILED STUDY OF THOSE FACTORS AFFECTING THE USEFUL LIFETIME OF THE CONTINUOUS CHANNEL ELECTRON MULTIPLIER. McCullough, E. C. (Univ. of Maryland, College Park). Nucl. Instrum. Methods, 60: 351-3(Apr. 1968).

The useful lifetime of the channel electron multiplier during prolonged counting at moderate count rates was found to be determined solely by the counting rate and operating voltage, and in the absence of any changes in these, an asymptotic value of gain can be expected to be maintained indefinitely. Electronic sensitivity criteria have also been established. (auth)

19204 CURRENT INTEGRATOR FOR USE WITH LOW VARIABLE CURRENTS. Gupta, S. K. (Tata Inst. of Fundamental Research, Bombay). Nucl. Instrum. Methods, 60: 323-5(Apr. 1968).

A transistorized current integrator using a very high input impedance has been designed. It is found to be linear in the range 1 nA to 10 μA. The leakage has been reduced to $\sim 5 \times 10^{-12}$ A and reproducibility of the calibration is less than $\pm 0.3\%$. (auth)

19205 PSEUDORANDOM TRULY UNIFORM NOISE GENERATOR. Abbattista, N.; Marino, D.; Plantamura, V. I. (Univ., Bari, Italy). Nucl. Instrum. Methods, 60: 317-22(Apr. 1968).

A pseudorandom noise generator with truly uniform amplitude distribution derived from the Fibonacci's congruential additive sequence is presented. Its period is 3×2^{17} terms. The digital output is a N(1 + 13) bits word which feeds a DAC in order to obtain a multilevel or pulse signal. A time interval sequence with uniform distribution is also available. (auth)

19206 SIMPLE SYSTEM PROGRAMMER FOR RADIOACTIVE HALF-LIFE MEASUREMENTS IN THE MILLISECOND TO SECOND RANGE. Flammang, N. K. (McDonnell Douglas Corp., St. Louis). Nucl. Instrum. Methods, 60: 326-8(Apr. 1968).

A simple electronically pulsed relay driver is described. Its period is in the range 0.5-50 sec with a 2.5-97.5% duty cycle. The relay driver output controls a cyclotron, pulse height analyzer and detection system in a specific timing sequence for radioactive half-life measurements in the msec to sec range. (auth)

19207 EFFICIENCY OF A FAST PHOTOMULTIPLIER ASSOCIATED WITH A THRESHOLD CIRCUIT. Camhy-Val, C.;

Dreux, M.; Dumont, A. M.; Marchal, J. (CNRS, Paris). Nucl. Instrum. Methods, 60: 333-4(Apr. 1968). (In French).

The importance of the threshold of the electronic circuitry which follows the photomultiplier, in photon counting techniques, is discussed. (auth)

19208 DIFFERENTIAL TIME-TO-AMPLITUDE CONVERTER. Sen, P.; Patro, A. P. (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Instrum. Methods, 60: 335-6(Apr. 1968).

A time resolution, fwhm = 0.46 nsec and 0.55 nsec with slopes of 0.09 nsec for 20% and 40%, respectively, of the upper Compton edge of ^{60}Co γ-rays, has been achieved using RCA 6810A photomultipliers with higher cathode to first dynode potential and a differential time-to-amplitude converter system. (auth)

19209 STATISTICAL EQUALIZATION METHOD IN TPHC. Abbattista, N.; Coli, M.; Plantamura, V. L. (Istituto di Fisica, Bari, Italy. CNEN, Frascati, Italy). Nucl. Instrum. Methods, 60: 337-9(Apr. 1968).

A statistical equalization method to improve the differential performances in time to pulse height converters is described. (auth)

19210 SENSITIVE DISPLAY TECHNIQUE FOR NUCLEAR MAGNETIC RESONANCE SIGNALS. Brown, R. Armstrong (CERN, Geneva). Nucl. Instrum. Methods, 60: 265-8(Apr. 1968).

Fast passage NMR signals are displayed on a linear timebase instead of the conventional sinusoidal timebase. For a given mistuning, the gain in sensitivity is a factor $4/\pi$ in linear displacement, equivalent to a factor of 4 in units of displayed resonance line width. Direct superposition of resonances provides a sharp alignment criterion. Absolute precision of alignment is limited by the level of harmonic distortion of the modulating field. (auth)

19211 ON-LINE COMPUTER CONTROL OF A TRIPLE AXIS NEUTRON DIFFRACTOMETER. Russell, M. C. B.; Martin, R.; Brown, L. H.; Smith, D. B. J. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 60: 237-45 (Apr. 1968). (AERE-R-5663).

Control circuits are described which have been developed for on-line supervision of a research instrument by a general purpose data processor. The functions of the instrument and its control circuits are described and their interaction with the computer program is explained. Details are given of a motor speed control circuit which is time shared between six shafts, and of circuits for use with optical encoders of the shaft angles. (auth)

19212 INVESTIGATION INTO A CHARGED TIRISTOR PHASE-SENSITIVE DEMODULATOR. Bilic, Ivka (Elektrotechnickog Instituta Poduzeca Rade Koncar, Zagreb). Nukl. Energ., 4: No. 3, 22-7(1967). (In Slovak).

The principle and the construction of a tiristor phase-sensitive demodulator (TFoD) are described. The results obtained by the investigation into the operation of the demodulator under charge were analyzed. The said investigations had to demonstrate in what way the charge effect does the operation of the TFoD, in what way the demodulations and the phase-sensitivity were obtained, and what are the possible improvements. The investigation made shows whether the TFoD is applicable to various regulation systems. Of particular interest and importance is the use of the TFoD in the regulation system operating the absorbtion rod in a nuclear reactor. Hence, all the investigations said were performed with an already developed regulation system of rods where the TFoD is one element of the system. (auth)

19213 CALCULATION OF TEMPERATURE FIELDS IN PLASMATRON ELECTRODES. Uryukov, B. A. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 84-91(Sept.-Oct. 1967). (In Russian).

Temperature fields in plasmatron (electric arc heater) electrodes were calculated, assuming that plasma electrodes are hollow cylinders with arc spots moving over one side of the cylinder surface while the other was cooling. (R.V.J.)

19214 MEASUREMENT OF THE ABSORBED ENERGY BY A COMPENSATION TYPE CALORIMETER. Hamanaka, Kiyoshi; Yoshimura, Masao; Shinozaki, Yoshiharu (Tokyo Metropolitan Isotope Research Center). Radioisotopes (Tokyo), 17: 57-62 (Feb. 1968).

A compensation type calorimeter was devised in order to measure the absorbed energy of various materials irradiated by electron beams of 1.5 MeV generated from a Van de Graaff type accelerator. The measurements made proved that the calorimeter served as a practical and satisfactory instrument for this purpose. Using 1.5 MeV electron beams, the energy absorption coefficient for polyvinyl chloride sheet of 100 mg/cm^2 in thickness was found to be 9.8%, and the value was 12.1%, 7.2%, 9.4%, and 13.9% for polyethylene sheet, polyethylene powder, tetron sheet, and water, respectively. The spatial distributions of the energy dissipation of 1.5 MeV electron beams in polyvinyl chloride, polyethylene were also measured by the same method. (auth)

19215 SMALL VOLUME ORBITRON GAUGE WITH STABLE ION CURRENT CHARACTERISTICS. Fitch, R. K.; Thatcher, W. J. (Univ. of Astron, Birmingham, Eng.). J. Phys. E, 1: 317-19(Mar. 1968).

An orbitron ionization gauge of small volume and simplified design is described. The gauge has a sensitivity of up to 5000 torr^{-1} and has been found to exhibit stable ion current characteristics for various filament bias potentials. It has been calibrated against a Bayard–Alpert ionization gauge using dry air, and has shown a linear variation of ion current with pressure over the range 1 mtorr to 10 ntorr. (auth) (UK)

19216 THE "NOISY" NUCLEUS. Etchells, A. H.; Lenihan, J. M. A. Instrum. Med., 14: 8-11(Jan. 1967).

Techniques employed in the medical applications of radioisotopes are dominated by the necessity for obtaining an ultimate signal with a maximum content of information, while accepting the inevitable and often severe limitations on the quantity of radioactivity which can be used or on the overall size of the detector. Some of the factors involved in this optimizing process are discussed. An outline is given of gamma spectra, solid state detectors, and liquid scintillation counting. Under limitations in clinical applications background and noise are discussed. Electronic accessories discussed include: Geiger counters; power supplies; amplifiers; pulse height analyzers; and scaling, counting, and timing units. Medical applications, tracer techniques, and future prospects are also discussed. (UK)

19217 MODIFICATION OF A TIME-OF-FLIGHT MASS SPECTROMETER FOR INVESTIGATION OF ION–MOLECULE REACTIONS AT ELEVATED PRESSURES. Futrell, Jean H.; Tiernan, Thomas O.; Abramson, Fred P.; Miller, C. Dean (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Rev. Sci. Instrum., 39: 340-5(Mar. 1968).

Extensive modifications of a Bendix time-of-flight mass spectrometer have been accomplished to permit investigation of ion-molecule reactions at ion source pressures up to about 1 Torr. In contrast with previous attempts to operate a TOF mass spectrometer, the present method employs a continuous electron beam and a dc extraction field in an ion source similar to those used in magnetic mass spectrometers. The master pulse initiating the timing cycle for mass analysis is applied to a focus grid in the low pressure region external to the source chamber and an auxiliary positive blocking pulse is applied to limit the sampling region during the on cycle. This modification eliminates degradation of instrument performance resulting from charge exchange and other secondary processes during ion acceleration, thereby extending the pressure range over which the ion source is operable by about two orders of magnitude and simultaneously increasing significantly resolution at moderate pressures. Additionally, a novel dual-inlet sample handling system which monitors directly and controls ion source pressure is described. Details of source design and performance are given, and it is demonstrated that kinetic data obtained using this system are in good agreement with previous results. (auth)

19218 LIQUID HELIUM FIELD-ION MICROSCOPE FOR RADIATION DAMAGE INVESTIGATIONS. Petroff, Pierre; Washburn, Jack (Univ. of California, Berkeley). Rev. Sci. Instrum., 39: 317-19(Mar. 1968).

A field ion microscope is described which allows in situ irradiation of a metal specimen at a temperature close to 5°K. It has been used with the 88 in. cyclotron at Berkeley which provides 10-MeV protons. The design permits field off irradiation of the specimen, as well as in situ temperature cycling. Qualitative observations on the surface damage of iridium upon field off and field on irradiation are given. (auth)

19219 COMBINED LEAK DETECTOR AND HIGH SENSITIVITY VACUUM GAUGE. Perkins, George D.; Robinson, Charles F. (Bell and Howell Labs., Pasadena, Calif.). Rev. Sci. Instrum., 39: 361-2(Mar. 1968).

A combined vacuum gauge and leak detector in which background currents are suppressed by an appropriately disposed magnetic field, permitting the measurement of total pressures below the limit of a Bayard–Alpert gauge. In leak detection, negative-ion-forming tracer gases such as Freon-12 can be detected at partial pressures below 10^{-11} Torr in the presence of common background gases at total pressures as high as 10^{-4} Torr. (auth)

19220 USE OF THE EL-X8 COMPUTER IN NEUTRON DIFFRACTION INVESTIGATIONS. Rietveld, H. M. (Reactor Centrum Nederland, Petten). Atoomenergie Haar Toepass., 9: 251-6(Nov. 1967). (In Dutch).

The application of the computer in investigations with two- or three-crystal neutron diffractometers is discussed. Punched tape, containing the results of computer-calculations for which only a few sample parameters were needed, is used to control the stepwise or continuous adjustment of the settings of the apparatus. The computer is also used for evaluation of the experiments. In single-crystal work it separates peaks and background and then determines the peak parameters. A plotter is used with powder samples, subsequent least-squares analyses determines the parameters of the crystal structure of the investigated material. (JJTB)

19221 SEISMOLOGICAL AND GEOPHYSICAL INSTRUMENTATION IN REACTOR SAFETY. Lomenick, T. F.; Robertson, Herbert (Teledyne Industries, Garland, Tex.). Nucl. Safety, 9: 120-4(Mar.-Apr. 1968).

Seismic instruments for operating scram systems are used in some experimental and fissile-material production reactors; however, they are not being generally considered for most power reactors. Instrumentation for evaluating reactor sites includes certain systems developed for seismology and geophysics. Accelerographs could be used to record strong motion at reactor sites, and seismographs could be used to record earthquake activity at prospective sites. Other instruments of possible, but unproved, value in reactor siting include tiltmeters, strainmeters, magnetometers, gravity meters, earth resistivity meters, and telluric current sensors. Geophysical techniques, such as the refraction and reflection seismic methods developed for oil exploration, may be used for investigating reactor sites both on land and at sea. (auth)

19222 DECOMPOSITION OF H_3^+ IONS IN THE ANALYZER TUBE OF THE MASS SPECTROMETER. Ioanoviciu, Damaschin; Ursu, Daniel (Inst. of Atomic Physics, Cluj). Rev. Roum. Phys., 12: 899-906(1967).

Dependence of the ionic current on pressure and source fields in case of simultaneous spontaneous and collision induced decompositions is calculated. On this basis a simple method for measuring average life time of metastable ions is described. This method employs the extrapolation to zero pressure at different repeller voltages. Measurements indicate the presence of an ordinate at origin which permits to suppose spontaneous decomposition of H_3^+ ions. (auth)

19223 FAST RECOVERY PROBE AND RECEIVER FOR PULSED NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY. Lowe, I. J.; Tarr, C. E. (Univ. of Pittsburgh). J. Phys., E, 1: 320-2(Mar. 1968).

A single coil probe and receiver for use in pulsed nuclear magnetic resonance experiments are described. The impedance transformation properties of a one-quarter wavelength line are used to protect the receiver during the radio-frequency pulse. The probe is very efficient in its use of rf power to create an oscillating magnetic field, and the overall system has a fast recovery time (less than 4 μs at 30 MHz). (auth) (UK)

19224 PERMANENT MAGNET FOR A NUCLEAR MAGNETIC RESONANCE SPECTROMETER. Boltezar, E.; Petrinovic, M.; Sedlacek, M. (Inst. Ruder Boskovic, Zagreb). J. Phys., E, 1: 323-5(Mar. 1968).

A permanent magnet with columnar crystal material (columax) and a pole gap of 35 mm is described. A magnetic field induction of 1.2677 T has been achieved. The parallelism of the pole faces can be adjusted by means of three wedge adjustment devices which move one pole cap. Some details of the magnet pole pieces, the construction of the pole caps, the magnetization and testing of the magnet are given. The magnetic field homogeneity over a sample volume of 0.05 cm^3 is to 1 part in 10^7. (auth) (UK)

19225 SYSTEM FOR PROTECTING VARIABLE TEMPERATURE NUCLEAR MAGNETIC RESONANCE PROBES AGAINST DAMAGE BY OVERHEATING. Heathcote, A. (Imperial Chemical Industries Ltd., Macclesfield, Eng.). J. Phys., E, 1: 356-7(Mar. 1968).

The device described prevents damage to variable temperature nuclear magnetic resonance system probes in fault conditions, including gas flow failure. (auth)

19226 SOME CONSIDERATIONS OF SAFETY HANDLING OF X-RAY DIFFRACTION APPARATUS. Konishi, Emiko; Ono, Michizane (Tokyo Univ.). Hoken Butsuri, 2: 57-66(June 1967). (In Japanese).

Practical considerations of safety in handling of x-ray diffraction apparatus are discussed. It is pointed out that most accidental hazards result either from mishandling or carelessness, regulations are imperfect at present, and safety controls are inadequate. Monitoring and survey techniques were investigated in detail, and it was concluded that the qualitative monitoring of leakage and scattered radiation is important rather than the quantitative dose rate measurements. Studies showed that unnecessary radiation exposure of the operator occurs mainly in the process of tube adjustments and sample positioning. Safety measures suggested include the use of an effective shield for protection, an operation manual for safety handling, and knowledge of the special characteristics of each piece of equipment. (NSA of Japan) (TSS)

19227 TRANSISTOR HAVING CONSTANT GAIN OVER A BROAD TEMPERATURE RANGE. Sander, Howard H. (to United States Atomic Energy Commission). U. S. Patent 3,374,408. Mar. 19, 1968.

A method for achieving constant current gain over a range of operating temperature from about 300°K to about 76°K for an n-p-n silicon transistor whose current gain normally decreases with decreasing temperature to a valley point, increases to a peak at about 76°K, and thereafter decreases toward zero is described. The steps of irradiating the transistor to a predetermined radiation level, adjusting the operating collector current of the transistor to a preselected level, and the resulting amplifying circuit are discussed. (AEC)

19228 CORPUSCLE SORTER. (to United States Atomic Energy Commission). British Patent 1,103,190. Feb. 14, 1968. Priority date June 4, 1965, United States.

The design of an apparatus for separating particles suspended in a liquid is presented. An acoustic driver is used to jet the liquid through a nozzle so that equal-size droplets are formed. These droplets are then charged and separated by electrostatic means. (W.H.K.)

19229 POWER SUPPLY SYSTEM (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1689).

51 drawings.

A power supply system is described which is housed in a forced air cooled weatherproof metal cabinet 37 in. wide by 62 in. deep by 90 in. high. The cabinet is suitable for floor mounting or free standing. Power supply input is 480 V 60 cps from a 3 phase, 3 wire ungrounded ac system. The output is adjustable from 1 to 100% in the following 4 ways: (1) 6 units connected in parallel—150 V dc, 2000 A; (2) 3 units connected in parallel and 2 connected in series—300 V dc, 1000 A; (3) 2 units connected in parallel and 3 connected in series—450 V dc, 667 A; and (4) 6 units connected in series—900 V dc, 333 A. (For details see TID-4100 Suppl. 44.) (F.S.)

19230 ELECTRON SPIN RESONANCE SPECTROMETERS. Wilmshurst, T. H. London, Hilger, Ltd., 1967. 280p. 70s.

All facets of ESR instrumentation, from the simplest to the most complex spectrometer designs are discussed. Main headings are as follows: fundamental requirements; development of a basic spectrometer; microwave systems; spectrometer cavities; superheterodyne spectrometers; automatic frequency control systems; low-noise microwave preamplifiers; the spectrometer magnet system; electronic circuitry. (UK)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 20043.

19231 RADIATION DAMAGE TO SEMICONDUCTOR DEVICES FROM ELECTRON AND PROTON RADIATION. Baeuerlein, R.; Wohlleben, K. (Siemens-Schuckertwerke AG, Erlangen, Ger.). Raumfahrtforschung, 12: 16-23(Jan.-Mar. 1968). (In German).

Irradiation with energetic electrons or protons generally degrades the performance characteristics of semiconducting devices. Various phenomena which occur in semiconductor crystals due to energetic-particle irradiation are discussed, and experiments to investigate the radiation damage of solar cells and transistors are described. In addition it is described how the radiation load of semiconducting devices in the radiation belt of the earth can be calculated. The shielding of solar cells by cover glasses and of transistors by their cases is taken into account. Also, the calculated degradation of solar cells and transistors is discussed for the satellite project AZUR and for a satellite in a synchronous orbit. (auth)

19232 IRRADIATION EFFECTS ON MOS DIODES. Chisaka, Haruo; Shinozaki, Yoshiharu (Tokyo Metropolitan Isotope Research Center). Radioisotopes (Tokyo), 17: 63-7(Feb. 1968).

The C-V characteristics of MOS diodes were measured at the gate bias of 10, 0, and −10V during the irradiation by ^{60}Co γ-rays. It is found that C/C_0 curves shift to more negative voltage with

the increase of irradiation dose and saturate at about 3×10^6 rads. The results are explained by introducing the assumption of donor centers which are formed probably by the mismatching between silicon and oxygen atoms in the oxide-silicon interface. The donor centers interact with the generated holes and make the trapped positive charge in the oxide-silicon interface. The formation of the trapped positive charge is studied by several bias conditions and the number of N_{ss} is estimated. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 18710, 19104, 19322, 19361, 19375, 19377, 19378, 19390, 19427, and 19451.

19233 (COO-209-144) COMBINATION OF ANTIGENS AND ANTIBODIES. BIOSYNTHESIS AND SPECIFICITY OF NORMAL AND IMMUNE PROTEINS. Annual Progress Report, February 1, 1967–January 31, 1968. Haurowitz, Felix (Indiana Univ. Foundation, Bloomington. Research Div.). Feb. 6, 1968. Contract AT(11-1)-209. 4p. Dep. CFSTI.

Studies were continued on the isolation and purification of antibodies directed against single antigenic determinants, namely, the acidic azophenylarsonate (As) group and the basic azophenyl-N-trimethylammonium (R_4N) group. Papain was used for cleavage of the native antibody molecules. Typing of rabbits used in the experiments revealed that they belonged to different allotypes. It was determined that there were at least 72 variants of anti-As and the same number of variants of anti-R_4N antibodies in the rabbit sera. Properties of sera were investigated in splenectomized rabbits and in x-irradiated rabbits with the spleen protected by a lead shield. It was determined that the anti-As and anti-R_4N antibodies, although directed against a single antigenic determinant, were just as heterogeneous as normal immunoglobulins, and that they differed from each other by variations not only in parts of the molecule remote from the specific combining sites, but also by the amino acid sequences in the combining sites. Peptides obtained by tryptic digests of anti-As and anti-R_4N are being separated from each other by column chromatography. (H.L.W.)

19234 (COO-1156-24) UPTAKE AND ELIMINATION OF ^{134}Cs BY MULE DEER. Hakonson, T. E.; Whicker, F. W. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). May 15, 1967. Contract AT(11-1)-1156. 25p. (CONF-670503-28). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

To establish some basis for predicting cesium accumulation in wild mule deer (Odocoileus hemionus hemionus), studies were undertaken to determine uptake and elimination rates under various conditions. In several separate experiments, up to 14 deer were given an 85 μCi acute oral dose of $^{134}CsCl$. Excretion estimates were made by daily whole body counting. Throughout the various experiments, biological half times associated with the two-component retention curves averaged about 0.5 days and 14 days, and the value of the slow elimination component extrapolated to the time of dosing averaged 77% of the initial dose. It was found that cesium elimination rates of yearling and adult deer were not significantly different. However, fawns (<5 months old) eliminated cesium more rapidly than adults. Sex per se had no significant effect on cesium elimination rates. Reduced feed intake and larger body weights significantly increased the cesium elimination half times. Cesium uptake and elimination rates in deer fed dietary levels of 0.8% and 6.0% potassium and 9.6% and 24.1% crude fiber were not significantly different. Deer confined to 3 × 6 foot and 12 × 20 foot pens did not have significantly different cesium elimination rates. (auth)

19235 (COO-1282-1) RADIOISOTOPIC STUDIES OF RETICULOENDOTHELIAL PHAGOCYTOSIS IN RELATION TO NORMAL AND NEOPLASTIC GROWTH, AND TO IMMUNE PHENOMENA. Final Technical Progress Report, June 15, 1963–June 14, 1967. Stern, Kurt (Illinois Univ., Chicago. Coll. of Medicine). Aug. 8, 1967. Contract AT(11-1)-1282. 13p. Dep. CFSTI.

MICE— phagocytosis in spleen of, effects of tumor transplants on; phagocytosis in spleen of, effects of spontaneous mammary carcinomas and lymphomas on; phagocytosis in spleen of, effects of dimethylbenzanthracene and methylcholanthrene on; phagocytosis in liver and spleen of, effects of isologous ribosome injections on

RATS— immune reaction to doubly incompatible antigens in, effects of pre-immunization with incompatible antigens on (E.R.B.)

19236 (LF-36) VIRUSES ISOLATED FROM BEAGLE DOGS EXPOSED TO AEROSOLS OF ^{90}Sr AND ^{144}Ce. Technical Progress Report. Lundgren, D. L.; Clapper, W. E.; Sanchez, A. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex. Dept. of Microbiology). Oct. 1967. Contract AT(29-2)-1013. 21p. Dep. CFSTI.

Many isolations of coxsackie viruses B1, B3, and B5, and echovirus 6, related, if not identical, to human viruses of the same types were made from nose, throat, and rectal swabs of Beagle dogs. Six unidentified enteroviruses were also recovered. Except for the echovirus 6 such isolations have not been previously reported. Three groups of Beagles receiving an aerosol which provided an initial body burden of 35 μCi/kg ^{90}Sr, 90 μCi/kg ^{90}Sr, and 140 μCi/kg ^{144}Ce showed no difference in the incidence of coxsackie B viruses from that of controls. However, a significantly greater number of isolations of echovirus 6 and of an unidentified enterovirus were made from controls than from exposed dogs. Low neutralization antibody titres against coxsackie viruses B3 and B5 were found in some of the serum from the Beagles that were examined. No titres were observed for coxsackie virus B1, echovirus 6, or one of unidentified enterovirus which were the most frequently isolated. There was no correlation between virus isolation and serum titres. (auth)

19237 (NYO-1343-17) STUDIES ON THE PHYSIOLOGY OF MARINE ORGANISMS USING RADIOISOTOPES. Progress Report, April 1, 1967–January 31, 1968. Steinbach, H. Burr (Marine Biological Lab., Woods Hole, Mass.). Feb. 6, 1968. Contract AT(30-1)-1343. 8p. Dep. CFSTI.

A list of investigators participating in radiobiological research at the Marine Biological Laboratory in Woods Hole, Massachusetts, during the summer of 1967 is presented together with titles of their research projects and isotopes used. (H.L.W.)

19238 (NYO-3148-12) ANNUAL PROGRESS REPORT [ON ERYTHROCYTE MEMBRANES] FOR THE YEAR ENDING JANUARY 31, 1968. Chan, Phillip C. (State Univ. of New York, Albany. Research Foundation). Oct. 27, 1967. Contract AT(30-1)-3148. 5p. Dep. CFSTI.

The ATP-dependent retention of sodium ions by fragments of human erythrocyte membrane required the presence of either cysteine or potassium ions. The activation by cysteine was specific when compared to various cysteine analogues. Ouabain inhibited the potassium-activated ATP-dependent retention of sodium and partially inhibited the cysteine-activated retention. Possible mechanisms for ATP-dependent sodium retention are discussed. Experiments on the effect of DTNB (5,5′-dithiobis (2-nitrobenzoic acid)) on ATPase in erythrocyte membranes demonstrated that some of the sulfhydryl groups in the red cell membrane are essential specifically for the Na, K-activated membrane ATPase, and these sulfhydryl groups are not accessible to DTNB in the extracellular medium. (H.L.W.)

19239 (ORO-3564-3) PROGRESS REPORT [ON RESPONSES AND STRUCTURE AMPHIBIAN PITUITARY GLAND IN VARIOUS STATES OF FUNCTION]. Dent, James Norman (Virginia Univ., Charlottesville. Dept. of Biology). May 31, 1967. Contract AT(40-1)-3564. 11p. Dep. CFSTI.

The pituitary glands were removed from 40 newts, Triturus viridescens viridescens. The anterior thirds of the glands were reimplanted into subcutaneous pockets below the lower jaw in 20 of these animals, and the posterior thirds were reimplanted in the remaining 20 animals. Results of the experiment led to the conclusion that the thyrotropic cells were present in both anterior and posterior parts of the pars distalis and that the aglobular basophils that were not seen in the posterior part were not thyrotropes. Other studies were conducted on the effects of thiourea and of various temperatures on mortality rate among thyroidectomized newts. The mortality rate was lower at 18°C than at 24°C and lower at 12°C than at 18°C. The mortality rate among thyroidectomized animals kept immersed in thiourea was quite low and led to the conclusion that thickened epidermis was the major cause of death in thyroidectomized newts that were not immersed in a solution of thiourea. Pituitary glands of newts were removed, γ-irradiated, and reimplanted beneath the lower jaw. Doses of 10,000 R or more resulted in reduction of melanism in the newts indicating that the pars intermedia was inhibited by radiation. Microscopic examination of the sectioned glands revealed extreme damage at doses of 35,000 R or more. Other experiments were carried out on immunological tolerance to pituitary homografts in Triturus and pituitary transplantation in Desmognathus fuscus. (H.L.W.)

19240 BINDING OF CALCIUM AND STRONTIUM BY ALGINATES. Triffitt, J. T. (Medical Research Council, Harwell, Eng.). Nature (London), 217: 457-8(Feb. 3, 1968).

Sodium alginates markedly inhibit the intestinal absorption of

Sr in animals and man without appreciable effect on Ca absorption, and hence are of interest as possible therapeutic agents in cases of ingestion of ^{90}Sr. Alginic acid is a polymer of d-mannuronic acid and l-guluronic acid, and it has been shown that guluronic-rich fractions of alginate are the most effective in reducing Sr absorption in rats, both in vivo and in vitro. A study is described of the Ca-Sr ion exchange reactions with various alginates. Monomeric l-guluronic acid was found to show no detectable binding capacity for Ca or Sr ions under the experimental conditions employed, this being solely a property of the polymer. It was also found that Ca and Sr ions formed a 1:1 complex with all alginate fractions studied. Formation constants for the strontium complex were 1.5 to 4 times greater than for the calcium complex. There was good correlation between guluronic acid content and strontium alginate formation constants, whereas this was not the case for calcium alginate. No marked inhibitory effect on intestinal absorption has been described for other cations. (UK)

19241 CHANGE IN THE ACTIVITY OF THE CHOLINESTERASE IN THE CENTRAL NERVOUS SYSTEM OF WHITE RATS DURING X IRRADIATION. Kripchenko, I. P.; Gromyko, A. S. Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk, No. 3, 123-4(1967). (In Russian).

The results of the study of the activity of cholinesterase during x irradiation at a dose of 40 R in different sections of the central nervous system were reported. The changes observed in the activity of the cholinesterase after irradiation were seen in the cerebellum. In the hemispheres of the front cerebrum the activity of the ferment exceeds somewhat the control activity one and five hr after irradiation. In the back cerebrum the opposite picture was observed. The degree of depression of cholinesterase activity was sharpest in the cerebellum. The hemispheres of the front cerebrum and the cerebrum functionally connected with it react to the influence of x radiation which indicates the specificity of mediator exchange in each irradiated section of the central nervous system. (tr-auth)

19242 DEPOSITION OF TRIGLYCERIDES OF INCREASED CARBON NUMBER IN IRRADIATED RAT MARROW. Snyder, Fred; Wood, Randall (Oak Ridge Associated Universities, Inc., Tenn). Radiat. Res., 33: 142-9(1968).

Changes in the fatty acid metabolism of bone marrow cells exposed to gamma radiation involves primarily the stimulation of triglyceride formation. This metabolic alteration appears morphologically as an increased number of fat cells, that reaches a maximum approximately one week after total-body irradiation (TBI). Triglycerides of femoral bone marrow, liver, plasma, and perirenal fat were isolated by preparative thin-layer chromatography (TLC) from control and irradiated (800 R) Carworth Farms Nelson strain rats. The purified triglyceride fractions were separated further by $Ag(NH_3)_2^+$ TLC and by gas-liquid chromatography (GLC). Stereospecific fatty acid analysis of the triglycerides was also done. The period for maximal triglyceride biosynthesis was three to four days after TBI. The pattern of irradiated marrow triglycerides on the argentation layers was similar to the control pattern, but GLC showed that the newly formed triglycerides in the irradiated bone marrow had a higher carbon number than those in control marrow. This change was not found in the triglycerides of other tissues examined before and after TBI. In both control and irradiated animals, plasma and liver contained triglycerides of higher carbon number than did bone marrow and adipose tissue. Stereospecific analysis of the fatty acid positions of the triglycerides showed that the change in triglyceride type caused by irradiation was due to a shift in the distribution of the C-16 and C-18 fatty acids in positions 1 and 3. No change occurred in the fatty acid composition of position 2 after irradiation. (auth)

19243 EARLY EFFECTS OF RADIATION ON THE BIOSYNTHESIS OF DEOXYRIBONUCLEIC ACID. Pierucci, Olga (Roswell Park Memorial Inst., Buffalo). Radiat. Res., 32: 760-79 (1967).

The rate of ^3H-thymidine incorporation into spleen and thymus DNA of whole-body-irradiated DBA/2 mice was investigated. We observed a diphasic incorporation pattern in both the DNA fraction that was insoluble in 0.14M NaCl and the fraction that was soluble in 0.14M NaCl and insoluble in 0.2N PCA (free DNA). An initial decrease was observed when ^3H-thymidine was injected during the first 15 minutes after irradiation. The decrease of incorporation was followed by an increase when the thymidine was given between 15 and 30 minutes after irradiation, and after this time a continuous decrease in incorporation was observed. It was also found that after irradiation the newly synthesized DNA was more readily extracted from the nucleoprotein complex by sodium–trichloracetate–phenol than was preformed DNA. These effects were found to occur prior to a gross change in the lability of the preexisting DNA–protein complex. (auth)

19244 INFLUENCE OF ACUTE IRRADIATION DISEASE ON ETHANOL METABOLISM IN RATS. Kvetina, J.; Audrlicky, I.; Cellerova, J.; Vavrova, J. (Charles Univ., Hradec Kralove, Czech). Cesk. Fysiol., 16: 147-8(Mar. 1967). (In Czech).

The level of alcohol dehydrogenase in the liver after irradiation is either unchanged or increased. Experiments on rat liver perfused by a solution containing 0.55% of ethanol are described. No significant changes in alcohol decomposition could be determined due to irradiation of the rats at a dose of 600 R. (JPRS)

19245 NUMBER OF CELL GENERATIONS REQUIRED TO FIX THE TRANSFORMED STATE IN X-RAY-INDUCED TRANSFORMATION. Borek, Carmia; Sachs, Leo (Weizmann Inst. of Science, Rehovoth, Israel). Proc. Nat. Acad. Sci. U. S., 59: 83-5(Jan. 1968).

The number of cell generations required to fix the transformed state in x-ray-induced transformation was studied by allowing hamster cells to undergo a different number of cell generations after irradiation before the cultures become confluent, and then testing for the loss of fixation in the confluent cultures by the assay for transformed colonies. The results indicate that two cell generations are required for fixation of the transformed state. It is suggested that the cellular DNA has to replicate after irradiation to produce a DNA strand that codes for transformation, and that the transformed state is then fixed in cells where both strands consist of this new type of DNA. (auth)

19246 DISTRIBUTION OF RADIOACTIVITY IN MILK RESULTING FROM ORAL ADMINISTRATION OF ^{14}C-LABELED CARBARYL. Baron, R. L.; Palmer, Nancy J.; Ross, R.; Doherty, J.; Jacobson, W. C. (Food and Drug Administration, Washington, D. C.). J. Ass. Offic. Anal. Chem., 51: 32-4(Jan. 1968).

Carbonyl-^{14}C-labeled carbaryl administered orally to a lactating cow at a dose of 3.05 mg/kg resulted in the appearance of radiolabeled materials in milk. About 1% of the administered dose of ^{14}C was recovered in the whole milk with a maximum concentration of 2.6 ppm carbaryl equivalents found in 9 hr. Radiometric assay of the milk fat showed a maximum level of 4.1 ppm carbaryl equivalents. Analysis of the skim milk by thin layer chromatographic assay failed to show the presence of carbaryl. (auth)

19247 THE EFFECT OF IRRADIATION ON SUB-CELLULAR PARTICLES: DESTRUCTION OF SULPHYDRYL GROUPS. Wills, E. D.; Wilkinson, A. E. (Medical Coll. of St. Bartholomew's Hospital, London). Int. J. Radiat. Biol., 13: 45-55(1967).

Thiol groups of rat-liver nuclei, mitochondria, lysosomes, and microsomes were destroyed by irradiation in vitro with electron doses of 5 to 50 kilorads. Significant destruction of thiol content occurred in all sub-cellular fractions immediately after a dose of 5 kilorads, the percentage of –SH groups destroyed being 9.5% in the nuclei, 23% in the lysosomes, 9.1% in the mitochondria, and 2.8% in the microsomes. The percentage of thiol groups destroyed increased with radiation dose in all fractions. Incubation in air or oxygen at 4°C, 20°C, or 37°C after irradiation caused further destruction of sulphydryl groups, but this did not occur after incubation in nitrogen. It is suggested that the destruction of –SH groups is a result of oxidation by free radicals produced in the aqueous phase and is not a result of oxidation by lipid peroxides. (auth)

19248 TOXICITY OF LITHIUM FLUORIDE. Spoor, Norman L. (Atomic Energy Research Establishment, Harwell, Eng.). Ann. Occup. Hyg., 11: 23-5(Jan. 1968).

Small amounts of lithium fluoride are used in thermoluminescent dosimetry of ionizing radiation, exposing laboratory staff to a potential hazard from inhaled LiF. An attempt is made to assess the toxicity of lithium fluoride, and to demonstrate that it would be wrong to regard this substance as presenting a real hazard in the circumstances in which it is customarily used in radiation dosimetry. (auth) (UK)

19249 MORPHOLOGICAL CHANGES FOLLOWING ULTRAVIOLET MICROBEAM IRRADIATION OF PARTS OF NUCLEI OF LIVING CELLS. Naruse, Sensuke; Yatani, Rhuichi; Takeda, Susumu (Mie Prefectural Univ., Tsu, Japan). Radiat. Res., 32: 849-60(1967).

A small nuclear part of living interphase cells derived from eight kinds of animal species was irradiated with an ultraviolet (uv) microbeam, and the subsequent changes of the irradiated part were observed by phase-contrast and uv microscopy, microspectrography, and staining with the Feulgen and pyronine-methyl green methods. In these cells, the photoreactions were divided into three types on the basis of phase-microscopic and deoxyribonucleic acid (DNA) changes. In type one, the irradiated part was observed as a pale-contrast and decreased uv absorption area in

newt peritoneal leukocytes and grasshopper spermatocytes. In type two, the irradiated part appeared as a dark-contrast and increased uv absorption area in two kinds of human cells in culture, cultured chick embryonic fibroblasts, and two kinds of ascites tumor cells. In type three, in human blood monocytes, the phase contrast of the irradiated part changes from pale to dark proportionally with the irradiation doses on contrast to a progressive decrease in uv absorption. The changes of type three were reproducible in model experiments with extracted DNA and DNP in vitro. The mechanisms inducing the differences in these reaction types remained obscure. (auth)

19250 DNA DEGRADATION BY DECAY FROM INCORPORATED TRITIUM COMPOUNDS IN ESCHERICHIA COLI. Person, Stanley; Sclair, Morton H. (Pennsylvania State Univ., University Park). Radiat. Res., 33: 66-73(1968).

Radioactive decays from each of three intracellularly incorporated tritium compounds--thymine-methyl-^{3}H (a DNA precursor), uracil-5^{3}H (a RNA precursor), and histidine-^{3}H (a protein precursor) caused degradation of DNA in Escherichia coli as measured by loss of thymine-^{14}C label previously incorporated into DNA. Degradation is specific for DNA, as cells labeled with uracil-5^{3}H or histidine-^{3}H show little loss of these RNA and protein specific precursors, even after extensive loss of thymine-^{14}C label. As much as 80% of the cellular DNA was degraded as a result of decays from each of the tritiated compounds; but the rates of degradation varied, being greater for thymine-methyl-^{3}H than for uracil-5^{3}H and histidine-^{3}H decays. The kinetics of DNA degradation for each of these incorporated compounds bear a relationship to each other that is similar to that previously reported for kinetics of inactivation produced by the same compounds in the same cell line. (auth)

19251 BIOCHEMICAL STUDIES OF SPLEENS OF HEAVILY IRRADIATED MICE TRANSFUSED WITH BONE MARROW. Wu, H. M.; Lewis, J. P.; Sky-Peck, H. H.; Trobaugh, F. E. Jr. (Presbyterian-St. Luke's Hospital, Chicago. Univ. of Illinois, Chicago). Radiat. Res., 33: 50-65(1968).

The splenic weights, rates of DNA synthesis, and contents of RNA, DNA, lipid, and protein were determined in heavily irradiated mice at 18 time intervals after irradiation and transfusion with graded doses of marrow cells. During the first four days after irradiation, the values of all characteristics fell to a similar degree in all animals, regardless of the dose of protective cells. Following this, regeneration occurred, and the higher the dose of protective cells administered, the sooner normal values of each characteristic were reached. RNA and protein were the first characteristics to be regenerated, followed in order by splenic weight, content of lipid, and content of DNA. The amount of DNA synthesized in the spleen seemed to provide the best biochemical predictor of recovery from irradiation, and those doses of cells that permitted synthesis of normal quantities of DNA were those that permitted recovery from lethal irradiation. (auth)

19252 RAPID LABELING OF RNA IN SACCHAROMYCES CEREVISIAE DURING GAMMA IRRADIATION CORRELATED WITH CATALASE FORMATION. Wagle, Mangala M.; Nadkarni, G. B. (Bhabha Atomic Research Centre, Bombay). Radiat. Res., 33: 174-81(1968).

Increased catalase activity in the gamma-irradiated cells of Saccharomyces cerevisiae is shown to be associated with an active turnover of RNA. The rapidly labeling fraction of RNA from the irradiated cells was separated after pulse-labeling with ^{32}P by a column chromatographic procedure. Appearance of this RNA component was also observed during catalase synthesis induced by aeration and H_2O_2 addition. Such a relationship was not obtained for cytochrome oxidase, that was induced only by aeration but not by other treatments. Variation in the responses of these two enzymes to gamma irradiation was discussed. (auth)

19253 INFLUENCE OF IONIZING RADIATION ON THE OXIDATIVE PHOSPHORYLATION, ADENOSINE TRIPHOSPHATASE, AND APYRASE IN POTATO TUBERS. Jaarma, Maire (Stockholm Univ.). Acta Chem. Scand., 21: 2069-75 (1967).

The oxidative phosphorylation of isolated potato mitochondria was studied. Preparations obtained from γ-irradiated tubers were compared to preparations from non-irradiated tubers. Adenosine triphosphatase and apyrase activities in the mitochondrial, microsomal, and soluble fractions were also investigated. Differences between oxidative phosphorylation in mitochondria from treated and from untreated tubers were observed only when the uncoupling agent dinitrophenol was present or when sub-optimal conditions prevailed. A minor increase was observed in the activity of apyrase isolated from irradiated tubers as compared to the corresponding enzyme from control tubers. (auth)

19254 EFFECTS OF POTASSIUM IODIDE AND METHYLTHIOURACIL ON THYROID UPTAKE AND WHOLE-BODY BURDEN OF RADIOIODINE. Takeuchi, Yoshiko; Yoshizawa, Yasuo (Tokyo Univ.). Radioisotopes (Tokyo), 17: 75-80(Feb. 1968).

Rats were given various doses of KI or methylthiouracil at various intervals following administration of ^{131}I. Thyroid uptake of ^{131}I was determined by using a scintillation counter and the whole-body burden was determined by use of a whole-body counter. Graphs are presented to show effects of KI and methylthiouracil on thyroid uptake and whole-body burden. The thyroid uptake of radioiodine was decreased to about 10% of the control group and the whole-body burden to about 30% of the control group. Methylthiouracil was more effective than KI when a longer time interval had elapsed after the intake of radioiodine. (H.L.W.)

19255 METABOLIC BEHAVIOR OF THE ^{51}Cr LABEL IN THE HUMAN BODY AFTER THE INTRAVENOUS INJECTION OF $^{51}Cr^{+++}$: A CONTRIBUTION TO THE DIAGNOSIS OF ENTERAL PROTEIN LOSS IN EXSUDATIVE GASTROENTEROPATHY. Heinrich, H. C.; Gabbe, E. E.; Meineke, B.; Becker, K. (Univ., Hamburg). Med. Welt, 16: 835-9(Apr. 16, 1966). (In German).

The metabolism of ^{51}Cr was studied in normal subjects and in patients with enteral serum protein loss (exudative gastroenteropathy) following the intravenous injection of 135 to 240 μCi of $^{51}Cr^{3+}$ (as $CrCl_3$). About 9 to 14% of the injected ^{51}Cr, having a biological half life of eight days, was eliminated from the plasma space. The biological half life of the ^{51}Cr for the whole body was calculated from the measured ^{51}Cr whole-body retention. In normal subjects 58% of the ^{51}Cr, with a biological half life of 47 days, was excreted from the whole body. In patients with exudative gastroenteropathy 54% of the ^{51}Cr, with a biological half life of 43 days, was eliminated from the whole body. The normal fecal ^{51}Cr excretion was 0.5% of the injected ^{51}Cr in 5 days and 0.6 to 1.0% within 10 days. A cumulative ^{51}Cr fecal excretion of 1.0 to 7.5% after 5 days and 2.0 to 11% after 10 days was observed in patients with enteral serum protein loss. Since ^{131}I-polyvinylpyrrolidone and ^{131}I- or ^{51}Cr-labeled human serum albumin are available at present only as unstable and denaturated preparations, the intravenous injection of $^{51}Cr^{3+}$ is considered to be the most reliable, economical, and simple method for demonstrating enteral protein loss in persons with exudative gastroenteropathy. A test dose of 2 μCi ^{51}Cr is required if the cumulative ^{51}Cr fecal excretion can be measured with a sensitive 4π-geometry, large volume radioactivity detector. This reduces the radiation exposure to about 1 mrem or ~0.4% of the natural radiation dose to the human body (~260 mrem/yr). (BBB)

19256 RADIATION AND BIOLOGICAL MEMBRANES. Harris, J. W. (Univ. of California, San Francisco); Watson, G. M. At. Energy Aust., 11: 6-9(Jan. 1968).

In vitro suspensions of lysosomes were prepared and exposed to gamma radiation. Criteria for injury were leakage of enzymes or other proteins into the suspending fluid and disruption of the particles. The rupture of lysosomes was observed by visible clearing of the suspension. Proteins or enzymes escaping from the lysosomes were measured by high-speed centrifugation. The effects of radiation dose, composition of electrolyte solutions, and ionic concentration were observed. The lysosomes were very radiosensitive. One effect of radiation was to mobilize membrane-associated enzymes. (H.L.W.)

19257 SURGICAL IRRADIATIONS. At. Energy Aust., 11: 5(Jan. 1968).

Gamma radiation was employed to treat human arteries, bones, and nerves to be used for grafting operations in Australian hospitals. Unfavorable reactions of patients were prevented by this treatment. Infiltration of the graft area by lymphocytes and fibroblasts was greatly reduced by radiation treatment. (H.L.W.)

19258 EFFECT OF WHOLE BODY X IRRADIATION OF RATS ON NET SYNTHESIS OF ALBUMIN, FIBRINOGEN α_1-ACID GLYCOPROTEIN, AND α_2-GLOBULIN (ACUTE PHASE GLOBULIN) BY THE ISOLATED, PERFUSED RAT LIVER. John, David W.; Miller, Leon L. (Univ. of Rochester, N. Y.). J. Biol. Chem., 243: 268-73(Jan. 25, 1968).

Adult male Sprague-Dawley rats were exposed to whole-body x irradiation. One hour after 900 R and 2000 R and 2, 4, and 6 days after 900 R, their livers were perfused for 6 hours with defibrinated rabbit blood, with L-lysine-1-^{14}C and 250 mg of glucose infused for the first 4 hours. Net synthesis of several specific plasma proteins was estimated by serological measurements of changes in their concentration in perfusate. Net synthesis of albumin was decreased a maximum of 25% 4 to 6 days after 900 R, which was essentially the same as that evidenced by livers from unirradiated rats fasted for 5 days. Net synthesis of fibrinogen, estimated by chemical as well as serological measurements, was

about 1.5 times the normal rate 4 days after 900 R. Net synthesis of α_1-acid glycoprotein was increased at 2, 4, and 6 days after 900 R, with approximately 5 times the normal rate at 4 days. Although α_2 (acute phase)-globulin was present at low concentration in the plasma of some irradiated rats at the time of hepatectomy, no evidence was obtained for net synthesis of this protein during perfusion of their livers. Based on the premise that the half-lives of the messenger RNA for rat albumin and fibrinogen are less than 3 hours, the observation that 900 R and 2000 R of whole-body x irradiation failed to suppress synthesis of these proteins is interpreted to mean that x irradiation in these doses does not damage the DNA of intact rats enough to interfere significantly with transcription of these species of messenger RNA. Perfusions of livers from irradiated rats did not differ from controls with regard to bile secretion, net changes in urea and α-amino acid nitrogen, oxidation of L-lysine-1-^{14}C to $^{14}CO_2$, or incorporation of ^{14}C-lysine into plasma proteins other than albumin and fibrinogen. (auth)

19259 EFFECT OF X RADIATION ON THE ADAPTIVE FUNCTION OF "SOLUBLE" AZOTOBACTER RNA. Miroshnichenko, G. P.; Zaitseva, G. N. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 176: 463-6(1967). (In Russian).

Following up earlier experiments that indicated that the acceptor activity of Azotobacter RNA of several amino acids is affected by exposure to a 25 kR x radiation, the effect of the same dose of x radiation on the adaptive function of cRNA was studied. Incubation of Azotobacter vinelandii culture separation from the cells of the total cRNA and the amino acid synthetase were described in a previous publication. The results revealed that there is a definite difference between the normal and irradiated cRNA in the stimulation polynucleotide matrix concerning the transfer of ^{14}C-lysine-cRNA. No transfer was noted in the ribosomes when the cRNA was irradiated. It was assumed that a disturbance in the adaptive function of cRNA is caused by an injury of a portion of its molecule that is responsible for interaction with a ribosome. Similar observations were made earlier concerning the effect of ultraviolet radiation on cRNA. It is possible that the action of the ionizing radiation causes changes in the pyrimidine bases, forming dimers from two neighboring uracil residues. Although there is a similarity in the molecular action mechanisms of x and ultraviolet radiations other mechanisms that cause disturbances in the adaptive function must be considered. (TTT)

19260 EFFECTS OF ULTRAVIOLET RADIATION ON LIPASES OF ADIPOSE TISSUES IN THE RAT. Kerpel, Shmuel; Laudat, Philippe (INSERM, Paris). Compt. Rend., Ser. D, 265: 1733-6(Nov. 27, 1967). (In French).

Ultraviolet irradiation of the fat of epididymis appears to break down the lipase activity at a pH of 8.5 in fresh tissue homogenates. After incubation of the homogenates at 37°C in the presence of noradrenaline, irradiation destroys the lipase activity at a pH of 7. The mechanisms of these reactions are discussed. (tr-auth)

19261 CHANGES OF PROTEOLYTIC ACTIVITY OF TOTAL BLOOD OF MICE CAUSED BY WHOLE-BODY IRRADIATION. Erokhina, L. V. Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 253-6(1965). (In Russian).

The proteolytic activity of blood in totally irradiated mice was reduced by two times or more as compared with controls, due to the accumulation of the antiproteolytic factor in the blood of the exposed mice. Tyrosine content was increased and remained high during the entire period of the investigation (21 days). (auth)

19262 DISTRIBUTION OF RADIOACTIVE STRONTIUM, CESIUM, AND IODINE IN THE BODY OF SOME INSECTS. Cavalloro, Raffaele; Cirio, Ugo (European Atomic Energy Community, Ispra, Italy). Redia, 50: 187-96(1966-67). (In Italian).

The metabolic distribution of ^{137}Cs, ^{131}I, and ^{85}Sr was investigated in the adult and larval stages of Phytometra gamma L., Rhyacia c-nigrum L., Scotia segetum Schiff., and Triphaena pronuba L., the adult stages of Ephippiger ephippiger Fieb. Gryllotalpa gryllotalpa L., Gryllus campestris L., Homorocoryphus nitidulus Scop., Necrophorus sp., Oedipoda coerulescens L., and Trigonophora meticulosa L.; and the larval stages of Arge pagana Panz., Eudia pavonia L., Macrothylacia rubi L., Papilo machaon L., Pieris brassicae L., and Thaumetopoeca pityocampa Schiff. The radioisotopes were administered by incorporation into the diet or feeding solutions. All insects were fasted prior to dissection. Tissues analyzed for accumulation were exoskeleton, muscles and nervous system, alimentary canal (gut), salivary glands, hemolymph, gonads, fat body, and Malphigian tubules. Strontium-85 and ^{137}Cs accumulated primarily in the muscles and nervous system and in the hemolymph; some differences related to their respective mobilities were noted. There was a higher accumulation of ^{137}Cs in the gonads of the Lepidopteran species (avg 14.3%) than in those of the Orthopteran species (avg 3.1%). In the holometabolic species ^{137}Cs and ^{85}Sr accumulated mostly in the gut. Iodine-131 accumulated primarily in tissues with high lipid content, i.e., the fat body and exoskeleton. (B.H.S.)

19263 INCORPORATION OF ^{32}P ORTHOPHOSPHATE INTO THE PHOSPHOLIPIDS OF ELONGATING AVENA COLEOPTILES. Zimmerer, Robert P.; Hamilton, Robert H. (Pennsylvania State Univ., University Park). Plant Cell Physiol. (Kyoto), 6: 681-7(Dec. 1965).

Four phospholipids of Avena coleoptile tissue were identified as phosphatidyl inositol, phosphatidyl glycerol, phosphatidyl ethanolamine, and phosphatidyl choline. Indoleacetic acid (IAA) caused an increase in total uptake of ^{32}P and incorporation of ^{32}P in phospholipids, and also caused a shift in the proportions of identified ^{32}P phospholipids. Incorporation of ^{32}P into phosphatidyl choline was greater, while incorporation into phosphatidyl glycerol and phosphatidyl ethanolamine was less in IAA-treated tissue compared with untreated control tissue. (NSA of Japan)

19264 MEASUREMENT OF INTESTINAL FAT ABSORPTION WITH ^{14}C LABELED TRACERS. Kaihara, Shigekoto; Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore). J. Lab. Clin. Med., 71: 400-11(Mar. 1968).

A new method for measuring intestinal fat absorption with ^{14}C-labeled fat was modified from the procedure described by Abt and von Schuching and tested in 36 normal volunteers, 20 patients including 14 patients with malabsorption syndrome, and 6 subjects with neomycin-induced steatorrhea. This method consisted of 5 μc of ^{14}C-labeled tripalmitate. The maximum specific activity of CO_2 in the expired air 3 to 5 hours after the administration of the dose correlated with chemical determination of the fat (correlation coefficient −0.81). Advantages of the test are technical simplicity and avoidance of the need to collect feces or blood. (auth)

19265 EFFECT OF HYPOXIA ON COLONY-FORMING UNITS IN BONE MARROW. Fried, W.; Weisman, M.; Martinson, D.; Gurney, C. W. (Veterans Administration West Side Hospital, Chicago. Univ. of Illinois, Chicago. Rutgers Medical School, New Brunswick, N. J.). J. Lab. Clin. Med., 71: 422-8 (Mar. 1968).

Prolonged exposure to hypoxia does not result in a decrease in the number of colony-forming units in a leg. The colony-forming units do, however, become significantly more sensitive to the damaging effects of x irradiation after three days of hypoxia. We suggest that elevated erythropoietin levels result in an increased rate of erythropoiesis. This, in turn, either directly or indirectly stimulates multipotential stem cells to differentiate. To prevent a decrease in the pool of undifferentiated cells, the remaining ones are stimulated to proliferate more rapidly. Rapidly proliferating cells are, in turn, more radiosensitive. (auth)

19266 EFFECTS OF IRRADIATION ON THE METABOLISM AND BIOLOGICAL PROPERTIES OF NUCLEIC ACIDS. Kucan, Zeljko Nukl. Energ., 4: No. 3, 1-5(1967). (In Slovak).

One of the classical problems of radiobiology is the investigation of the effects of irradiation on the structure, metabolism, and function of nucleic acids. The importance of such investigation results from the central role played by nucleic acids in the living cell. Extensive investigations of the metabolism of nucleic acids in a unicellular organism, bacterium Escherichia coli, were carried out at the Institute Ruder Boskovic in Zagreb during the past ten years. The present article reviews a part of these investigations; metabolic degradation of deoxyribonucleic acid in irradiated bacteria, especial interest being paid to the radiobiological and biochemical aspects of the problem, radiation effects on the metabolism of ribonucleic acid after irradiation, and studies of the investigation of ribonucleoprotein particles—the ribosomes—by irradiation. (auth)

19267 SERUM ENZYMES AFTER THERAPEUTIC RADIATION: A STUDY IN PATIENTS WITH CARCINOMA OF CERVIX UTERI. Watts, C.; Goldberg, D. M. (Western Infirmary, Glasgow). Enzymol. Biol. Clin., 8: 379-86(1967).

Serial measurements were made on 11 serum enzymes in patients undergoing radiotherapy for cervical carcinoma. The enzymes measured were ketose-1-phosphate aldolase, alkaline phosphatase, isocitrate dehydrogenase, lactate dehydrogenase, malate dehydrogenase, aspartate aminotransferase, alanine aminotransferase, deoxyribonuclease, deoxyribonuclease II, and two other hydrolases that act on nuclear material. Blood was obtained before therapy, during Ra insertion, within 24 hr of Ra withdrawal, and two or three times weekly during supervoltage x-ray therapy. There were no recognizable patterns of enzyme response in the group as a whole, but some patients showed pronounced increases

in activity of one or more of the enzymes during some stage of radiotherapy. Isocitrate dehydrogenase appeared to be the enzyme most subject to change after irradiation. Deoxyribonuclease and DNAase II tended to be lower in the serum of the cancer patients than in the serum of healthy subjects, but no notable changes occurred after irradiation. An explanation of the observed unresponsiveness of the serum enzymes to irradiation is presented. (BBB) (TSS)

19268 SOME PECULIARITIES OF THE DISTURBANCE OF PROTEIN METABOLISM IN THE LIVING ORGANISM DUE TO IONIZING RADIATION. Graevskaya, B. M. Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 94-118(1965). (In Russian).

Whole-body irradiation of mice (600 R of x rays) increased the activity of proteases isolated from the spleen and liver. No increase in proteolytic activity was observed in extracts from the spleen locally irradiated, shielded during irradiation and irradiated outside the body. No direct connection was found between the intensification of proteolysis and necrobiotic changes. Aminotioles (AET and MEA) lessened the radioinduced increase in the activity of tissue proteinases, while carbon monoxide was ineffective in this respect. There were no noticeable differences in the breakdown of proteins isolated from the tissues of irradiated and unirradiated animals. The activity of tissue proteinases in intact animals of different species and strains was found to correlate with their radiosensitivity. The latter was reduced as the activity of proteinases isolated from tissues was slowing down. (auth)

19269 BIOCHEMICAL PECULIARITIES AND RADIOSENSITIVITY OF DIFFERENT MAMMALIAN SPECIES. Nuzhdin, N. I.; Graevskaya, B. M. Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 119-35(1965). (In Russian).

The radiosensitivity of different mammalian species (rats, mice, golden hamsters, and guinea pigs) and of strains (mice $CC_{57}Br$, BALB/c, and Kryukowskaya population) was compared with some of their metabolic features. Relatively more radiosensitive animal species and strains revealed the following features: higher content of adrenochromes in the adrenal glands; lower content of glycogen in liver tissue and of sugar in the blood; and also a marked difference in the character of changes in the sugar level in the blood on administration of hydrochloric acid adrenaline; and relatively lower activity of proteolytic processes in the spleen and the liver. The reasons for these correlations and the possibility of using the biochemical differences studied for assessing the animals' relative radiosensitivity was discussed. (auth)

19270 DETERMINATION OF URINARY ELIMINATION OF ^{131}I FOLLOWING GASTROINTESTINAL ABSORPTION OF THE ISOTOPE. Furnica, G.; Turcitu, Elisabeta (Institutul de Igiena, Bucharest). Igiena (Bucharest), 16: 297-305(May 1967). (In Rumanian).

Numerous ion-exchange resins were evaluated for use in separating ^{131}I from urine after administration of small doses. A method was developed for determination of urinary excretion of radioiodine in both inorganic and organic forms, based upon its retention on ion-exchange resins. Inorganic radioiodine is retained by strongly basic anionic resins to an extent of 90 to 95%, by slightly basic anionic ones 70%, and strongly acidic cationic ones 2 to 4%. About 32 to 35% of organic radioiodine is retained by strongly acidic cationic resins and 70 to 75% by anionic resins. By the method described it was possible to detect body burdens of ^{131}I as low as 4 nCi. Rates of elimination of ^{131}I in the urine after oral doses were determined under various conditions. (BBB)

19271 SPECIFIC ENZYME RESPONSES IN STARVED, GLUCAGON-TREATED OR IRRADIATED RATS, AND GENERAL CONSIDERATIONS ON THE MECHANISMS OF INDUCTION IN ANIMALS. Greengard, Olga (Harvard Medical School, Cambridge, Mass. New England Deaconess Hospital, Boston). Contract AT(30-1)-901. Advan. Enzyme Regul., 5: 397-405(1967). (NYO-901-66).

Starvation and the administration of glucagon exerted several similar effects on the levels of the rat liver tryptophan oxygenase and tyrosine aminotransferase. The most striking effect was the fifteenfold increase in the level of tyrosine aminotransferase by the synergistic action of glucagon and hydrocortisone. Irradiation, unlike actinomycin, inhibited the cofactor-type inductions of tryptophan oxygenase and tyrosine aminotransferase and did not influence their hormone-type induction. An operational definition of the mechanisms of enzyme induction is presented and discussed. (auth)

19272 ORTHOTOPIC AUTOTRANSPLANTATION AND ALLOTRANSPLANTATION OF THE LIVER: FUNCTIONAL AND STRUCTURAL PATTERNS IN THE DOG. Stuart, F. P.; Torres, E.; Hester, W. J.; Dammin, G. J.; Moore, F. D. (Peter Bent Brigham Hospital, Boston, Mass.). Ann. Surg., 165: 325-40 (Mar. 1967).

Various combinations of local graft x irradiation and systemic treatment with azathioprine and actinomycin C were used as immunosuppressive agents in 52 cases of dog liver transplantation. In orthotopic allotransplantation of the liver, four immunosuppressive protocols were tested. Actinomycin C alone did not prolong graft survival. Three protocols of various combinations of azathioprine, actinomycin C, and local x irradiation (two 150-R doses) were equally effective in their modest ability to prolong graft survival. Six dogs survived more than 50 days; the longest survivor lived 88 days. All six dogs were undergoing slow hepatic rejection and had upper gastrointestinal ulceration at the time of death. Massive bleeding from upper gastrointestinal ulcers was the immediate cause of death in five of the six dogs; ulceration was prevented by subtotal gastric resection but not by vogotomy and pyloroplasty. The ulceration was acid-peptic in nature and was possibly due to an humoral mechanism that was associated with hepatic rejection. (BBB)

19273 EFFECTS OF D_2O ON THE MECHANISM OF PIGMENT DISPERSAL IN THE MELANOCYTES OF FUNDULUS HETEROCLITUS: A PRESSURE-TEMPERATURE ANALYSIS. Marsland, Douglas; Meisner, Donald (Marine Biological Lab., Woods Hole, Mass.). J. Cell. Physiol., 70: 209-16(Oct. 1967).

The melanocytes of isolated fish scales (Fundulus heteroclitus) immersed in 0.1M aqueous KCl solution and in deuterated KCl solutions, in which 50 to 70% of the H_2O was replaced by D_2O, were observed at 300× magnification while they were subjected to increasing hydrostatic pressure, raised in increments of 1,000 psi in the range up to 16,000 psi. In one series of experiments the temperature was maintained at 20°C (±0.2°), whereas in the other it was kept at 25°C (±0.2°). Initially, all the melanocytes in the KCl media displayed a contracted, or punctate, form. With increasing pressures, gradually, expansion, or pigment granule dispersal, occurred but the degree of expansion at a given pressure depended upon the percentage of deuteration and the temperature. At 20°C in aqueous medium, total expansion, in which the pigment extended all the way out into the peripheral tips of melanocyte branches, occurred at 8,000 to 9,000 psi. At lower pressures the intermediate values, expressed as a percentage of the total, fell along a smooth, slightly sigmoid curve. In the deuterated media, similar curves were obtained, but the pressure levels required to produce a given degree of expansion were significantly higher. Thus, maximum expansion required the imposition of 14,000 psi in the 50% D_2O medium and of 16,000 psi in the 70%. Upon decompression, at the end of each experiment, the melanocytes quickly contracted, reaching a completely punctate form within three to four minutes. Similar relationships were found at 25°C, except that all the pressure values were significantly higher than those at 20°C. In fact the values for 25°, with 50% deuteration, were very similar to those for 20°, with 70% D_2O. The evidence tends to confirm conclusions, previously submitted, namely, that, as expansion occurs, the cytoplasm of the unicellular pigmentary effectors of the fish undergoes a progressive process of solation and that contraction involves a reestablishment of the original firm gel structure. Thus the well known solational effects of high pressure tend to be counteracted by agencies, such as increasing deuteration and temperature, that are known to foster protoplasmic gelations generally. (auth)

19274 TRITIATED THYMIDINE EFFECTS ON DNA, RNA, AND PROTEIN SYNTHETIC RATES IN SYNCHRONIZED L-CELLS. Krause, Margarida O. (Univ. of Toronto). J. Cell Physiol., 70: 141-54(Oct. 1967).

Exponentially growing L cells were synchronized by the double thymidine-block method and exposed to high specific activities of tritiated thymidine. DNA, RNA, and protein synthetic rates were measured through one cell cycle with 1-hour pulses of the appropriate ^{14}C-labeled precursors. Equivalent doses of tritiated water were substituted for tritiated thymidine in some experiments. Total amounts of DNA and histones per nucleus were determined photometrically in Feulgen and fast-green stained cells. It was observed that incorporated tritiated thymidine has an effect distinct from that of tritiated water and that it enhances the incorporation of the precursors at specific stages of the cell cycle, to a degree roughly proportional to the dose. Photometric data indicated an increase in DNA net synthesis and a metabolic instability of histones in the ^3H-thymidine-treated cells, resulting in higher DNA : histone ratios. (auth)

19275 CYTOTOXICITY BY NONIMMUNE ALLOGENEIC LYMPHOID CELLS: SPECIFIC SUPPRESSION BY ANTIBODY TREATMENT OF THE LYMPHOID CELLS. Moeller, Erna (Karolinska Institutet Medical School, Stockholm). J. Exp. Med., 126: 395-405(Aug. 1, 1967).

Nonimmune lymphoid cells were capable of causing cytotoxicity of H-2 incompatible mouse tumor cells in vitro in the presence of phytohemagglutinin (PHA), whereas syngeneic cells were not.

Semisyngeneic and x-irradiated (1500 to 3000 R) F_1 hybrid lymphoid cells were cytotoxic for target cells derived from one of the parental strains. In addition, parental nonimmune and x-irradiated lymphoid cells damaged hybrid target cells. It was concluded that one component of cytotoxicity was not related to an induction of a primary immune response in vitro, since F_1 hybrid cells are not capable of reacting immunologically against parental type target cells. Probably, cytotoxicity was caused by target confrontation with antigenically and/or structurally incompatible lymphoid cells. This conclusion was strengthened by the demonstration that isoantibodies produced in the target strain and directed against the allogenic lymphoid cells specifically suppressed cytotoxicity. Isoantibodies reacting against some but not all of the antigenic determinants of the lymphoid cells differentiating them from the target cells did not suppress cytotoxicity. The specific suppression of cytotoxicity by specific isoantibodies against the lymphoid cells supported the allogeneic inhibition concept. (BBB)

19276 PRIMARY IMMUNE RESPONSE IN GRAFTED CELLS. DISSOCIATION BETWEEN THE PROLIFERATION OF ACTIVITY AND THE PROLIFERATION OF CELLS. **Nisbet, Norman W.; Simonsen, Morten (Jones and Hunt Orthopaedic Hospital, Oswestry, Eng.). J. Exp. Med., 125: 967-81(June 1, 1967).**

Normal and irradiated Rhode Island Red x Light Sussex chicken embryos were injected with 0.1 ml citrated whole blood of adult White Leghorn donors of opposite sex. The primary immune response elicited by host antigens in a grafted population of immunologically competent cells was compared in conditions where the same dose of parental cells was grafted simultaneously to F_1 hybrid embryos of 13 or 17 days of age. The enlarged chimeric spleens harvested four days later were analyzed for donor cell proliferation by using the sex chromosomes as karyological markers, and for proliferation of immunological activity by transfer to secondary hosts of the same genotype. In nonirradiated embryos the percentage of dividing donor cells (i.e., the percentage of diagnosed metaphases found to be of donor origin) was on the average higher at seven days than on four days after injection and, for the same time, was higher from grafting on the 17th day of development than on the 13th to 14th day. Percentages in the irradiated recipients (750 to 1000 R) were higher. Although irradiation of the host increased the percentage of donor metaphases, it never abolished all host cell division. The net effect on spleen size in irradiated hosts was slight; the radioinduced atrophy of noninjected control spleens was prevented, but not much overcompensated by the donor cell proliferation. Whereas the total numbers of dividing donor cells were on the average 16 times higher in 17-day than in 13-day hosts, the recovery of immunological reactivity showed a six- to seven-fold difference in the opposite direction. The experiments casted doubt on the proposition that cellular proliferation was necessary for development of a primary immune response, and suggested that there existed an alternative way in which a primary immune response could unfold from involving a few to involving a much larger number of cells. (BBB)

19277 BODY NITROGEN IN IRRADIATION CHIMERAS. **Nutr. Rev., 24: 185-7(June 1966).**

Development of the secondary syndrome (homologous disease), as seen by changes in nitrogen balance, in mice given lethal doses of ionizing radiation and homologous bone marrow grafts is briefly reviewed. The failure to gain weight, or actual weight loss, which is part of homologous disease, occurs while the animals maintain a positive nitrogen balance as much as 2 times greater than that seen in nonirradiated, untreated control animals. Mice given isologous bone marrow infusions after irradiation exhibit a similar increase in positive nitrogen balance. These mice, however, gain weight at the same rate as nonirradiated mice. Food consumption of the 2 groups of irradiated mice is equivalent to that seen in the control group. No significant differences were found in nitrogen content of blood and thoracic viscera or of abdominal viscera. However, significant differences were noted in the distribution of nitrogen between skin and carcass when the homologous chimera group was compared with control and isologous groups. The skin of animals suffering from homologous disease clearly contained greater amounts of nitrogen. The failure to gain weight or the loss of weight associated with homologous disease, even with increased positive nitrogen balance, is explained, as follows: during the homologous reaction nitrogen is deposited in a noncellular integumentary compartment at the expense of other body tissues. If this material containing nitrogen had a lower nitrogen-to-body-weight conversion ratio than the tissues from which nitrogen was diverted, a loss in body weight could occur while nitrogen retention was increased. This could be the result of deposition of nitrogen in antibody-antigen complexes upon the surfaces of skin cells. (BBB)

19278 DEVELOPMENT OF IMMUNOLOGIC COMPETENCE IN GERMFREE AND CONVENTIONAL MICE. **Bosma, M. J.; Makinodan, T.; Walburg, H. E. Jr. (Oak Ridge National Lab., Tenn.). J. Immunol., 99: 420-30(Aug. 1967).**

The immune competence of germfree and conventional mice was assessed using a cell transfer technique. The capacity of transferred spleen cells under the following conditions was examined: an x-ray dose of 800 R, an antigen dose of 10 sheep red cells to 1 spleen cell, and a culture time of 7 days, a time at which a 2-fold increase in spleen cell dose ranging from 20 to 200×10^6 resulted in a 2-fold increase in the 7-day serum hemagglutinin titer. Immunologic competence of the spleen cells from germfree and conventional mice was assessed in terms of hemagglutinin and hemolysin formation in irradiated mice. The results revealed that germfree and conventional mice are immunologically alike as judged by: numbers of immunocompetent progenitor cells in the spleens of 3- and 13-week-old mice; kinetics of hemagglutinin and hemolysin formation by spleen cells of 3-, 9-, and 13-week-old mice, and of intact 13-week-old mice; and rate and magnitude of immunologic growth of the spleen during the 1st 25 weeks after birth. This naturally occurring microbial flora and maternal antibody are not basic requisites for the normal development of progenitors of hemagglutinin- and hemolysin-synthesizing cells. (BBB)

19279 RADIATION EFFECTS AND STUDIES IN VITRO IN THE EVALUATION OF THE POSSIBLE ROLE OF SECONDARY NODULES IN THE PREPARATION FOR A SECONDARY RESPONSE. **Thorbecke, G. J.; Jacobson, E. B.; Hochwald, G. M. (New York Univ., N. Y.). pp 587-94 of Molecular and Cellular Basis of Antibody Formation. Proceedings of a Symposium, Prague, June 1 to 5, 1964. New York, Academic Press, 1965.**

The changes in adrenocortical function following supralethal irradiation were studied in rats. The blood corticosterone level, and the in vitro corticosterone and aldosterone secretion by the adrenals were determined at different times following whole-body irradiation with 1300 R. It was determined that two phases appeared in the adrenocortical hormone secretion; these were more pronounced in the case of corticosterone. Acute corticosterone hypersecretion appeared after irradiation; following its cessation, a renewed increase in corticosterone production developed 48 to 72 hours later. The two phases were not as pronounced in the case of aldosterone production. The observed changes in secretion were largely supported by the histological findings. In conclusion, the disturbances in salt and water balance were correlated with the changes in adrenocortical function. (JPRS)

19280 CHANGES IN ADRENOCORTICAL FUNCTION FOLLOWING SUPRALETHAL WHOLE-BODY IRRADIATION. **Zsebok, Zoltan; Petranyi, Gyozo; Baumgartner, Edit; Fachet, Jozsef (Dept. Medical-Radiological Research Group, Budapest). Orv. Hetil., 107: 1496-9(Aug. 1966). (In Hungarian).**

The white and red pulp of spleen was studied in normal and irradiated rabbits at various times after injection of bovine γ-globulin (BGG). It was found that during the peak of antibody production (days four to five) most antibody formation occurred in the red pulp. By seven to eight days, much less antibody production could be found in the red pulp, and none in the white pulp. At this time the secondary nodules began to proliferate in the white pulp. Reinjection of antigen at this time changed the pattern of antibody formation. One day after the booster injection, the white pulp showed some antibody production and the red pulp was negative. One day later, both white and red pulp showed high production, suggesting the responding cells originated in the white pulp. No secondary response could be induced in vitro in either white or red pulp, but transfer experiments were successful in x-irradiated immature rabbits, used as the recipients. When a challenging injection of BGG was given with the cells, 10 out of 11 recipients of white pulp cells showed antibody in their serum seven to ten days after transfer. Only five out of 11 recipients of red pulp cells showed antibody, and their passive hemagglutination serum titers were significantly lower than those of the white pulp recipients. A 500-R dose of whole-body x irradiation, given 50 days after a primary injection of BGG, resulted in a permanent depression of the ability to make a secondary response. The effect of irradiation was studied on days 8, 21, and 52 after a primary injection of 10 mg BGG on the secondary response induced at various days after the irradiation. It was found that irradiation on days 21 or 52 resulted in a depression of the ability to make a secondary response which lasted for at least 12 days. However, irradiation on day 8 after the primary injection resulted in a profound but temporary depression of the ability to make a secondary response, from which rapid recovery occurred over the week following irradiation. Histologically, a destruction and reappearance of proliferating secondary nodules were found to correlate with this recovery of the ability to make a secondary response. The plasma cells were found to be relatively resistant to irradiation. The period of recovery (8 to 15 days after the primary injection) coincided with the time at

which, in normal rabbits, a rapid increase occurred in the degree of sensitization for a secondary response. These results suggested that secondary nodules contained cells which were specifically induced to proliferate in response to antigen, and which, upon maturation, were sensitized to give a secondary response upon reexposure to the same antigen. These mature sensitized cells produced in secondary nodules were probably lymphocytes which were long-lived and did not proliferate rapidly. (BBB)

19281 USE OF COMPUTERS IN MEASURING BODY ELECTROLYTES BY GAMMA SPECTROMETRY. Meneely, George R. (Louisiana State Univ., Shreveport); Ball, Con O. T.; Ferguson, John Lynn; Payne, Daniel D.; Lorimer, A. Ross; Weiland, Raymond L.; Rolf, Howard L.; Heyssel, Robert M. Circulation Res., 11: 539-48(Sept. 1962).

A computer program for measuring body potassium, as ^{40}K, determined in a whole-body counter, was developed. Adequate exploitation of the capabilities of a whole-body, γ-ray scintillation spectrometer requires fast data processing in integration of photopeak areas in multiple channels, evaluation of counting error by application of Poisson statistics, reduction of noise by smoothing processes, and normalizing spectra for time, for keV per channel, and for zero drift. This report describes how the whole-body counting facility was calibrated experimentally and the data electronically processed. Fifteen healthy subjects were counted after injection of ^{42}K. By referring the net dose received by each subject to the counting rates obtained by counting ^{42}K in the syringe in a standard position, an arbitrary unit dose of radioactivity received by the subject was obtained. The net ^{42}K counting rate obtained from the subject, divided by the net counting rate of the dose in the syringe, expressed the efficiency of the count in the subject in terms of counts per minute per unit of radioactivity. Expressions were derived for computing the ^{42}K body content from the data obtained using the IBM-650 computer. The time required to read a subject's data, process them, and punch out results was about 3 min. All the output data were delivered from the computer on 28 punched cards and printed on a single computer sheet. (BBB)

19282 REACTIVATION IN VITRO OF IMMUNOCOMPETENCE IN IRRADIATED MOUSE SPLEEN. Globerson, Amiela; Auerbach, Robert (Univ. of Wisconsin, Madison). J. Exp. Med., 126: 223-34(Aug. 1, 1967).

Restoration of immunological competence to irradiated adult mouse spleen was studied using an in vitro assay system. Competence of the spleen to evoke a graft-vs-host reaction in vitro was lost upon sublethal irradiation (550 R). Regeneration of immune competence occurred when such spleens were grown for 2 to 3 days in the presence of thymus tissue, but not when grown in the presence of a variety of other tissues. This thymic activity was demonstrated to occur across an intervening Millipore filter barrier. When lethal doses of irradiation were used, reactivation of immune competence did not occur unless both thymus and bone marrow were present. In this experiment the bone marrow appeared to supply the immunocompetent cells. (BBB)

19283 ON THE LUMINESCENCE OF L-TRYPTOPHAN AND L-TYROSINE IN AQUEOUS SOLUTION AT 77°K INDUCED BY X RAYS AND UV LIGHT. Steen, H. B. (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Photochem. Photobiol., 6: 805-16(Nov. 1967).

The luminescence spectra of L-tryptophan and L-tyrosine in aqueous solutions at 77°K during irradiation with uv and x rays were similar for the 2 types of radiation, differing only in that the yields of phosphorescence relative to fluorescence were considerably enhanced with x irradiation. The decay times for exponentially decaying phosphorescence, 6.6 and 2.7 sec for tryptophan and tyrosine respectively, were the same for both irradiations. The G value of x-ray-induced luminescence was about 10 for both tryptophan and tyrosine. Thus, about 30% of the total energy absorbed from x rays in these compounds was reemitted as light. It was concluded that the x-ray-induced fluorescence and phosphorescence originate from the same levels as does the luminescence caused by uv light, i.e., the lowest excited singlet and the lowest triplet level of the aromatic structure of these compounds. With x irradiation the enhanced ratios between the yields of phosphorescence and fluorescence indicated that some process other than excitation directly from the ground state contributed considerably to the luminescence yields. Assuming this process to be a recombination between the ionized molecule and its electron, it was calculated that the contribution to the luminescence yield from excitations directly from the ground state relative to that from ionizations was negligible for both compounds. (BBB)

19284 PRINCIPLE, METHOD, AND POSSIBILITIES OF USE OF A NEW ISOTOPE TECHNIC. Hoefer, Rudolf (Medizinische Univ., Vienna). Wien. Z. Inn. Med. Grenzgeb., 46: 297-309(Aug. 1965). (In German).

The time-concentration curve of a tracer is conventionally determined by taking serial samples following administration of the tracer. In principle, the same time-concentration curve may be obtained by administering a series of biologically identical tracers at different time intervals, before assaying a single sample for the concentration of the different tracers. The conventional method of serial sampling after one tracer will always be preferred when sampling is easy. The new method described can be used for obtaining an individual time-activity curve when serial sampling is difficult or impossible. Ideal tracers for such an experiment, e.g., tracers that are biologically identical, but can be identified if they are present in the same sample, are different radioisotopes of the same element. The technique of simultaneously using ^{125}I, ^{131}I, and ^{127}I for determining a time-activity curve with this new method is described. Some model experiments (thyroid uptake curves, iodine distribution in thyroid hydrolyzates) are described and the practical application of the technique for investigating the precursor relations of mono- and diiodotyrosine is presented. (40 references.) (BBB)

19285 RADIOIODINATION OF OXYTOCIN AND THE MEASUREMENT OF OXYTOCIN ANTIBODIES IN SERUM. Spellacy, W. M.; Carlson, K. L. (Univ. of Minnesota, Minneapolis). Obstet. Gynecol., 29: 862-4(June 1967).

To study the metabolism of oxytocin during pregnancy a sensitive, reliable assay system employing radioisotopes was developed. The use of radioimmunoassay for hormonal measurement required radioactive labeling of the substance to be studied; a modified method of radioiodination of oxytocin is presented. This radiolabeled oxytocin was used to test for antibodies to oxytocin in the circulating blood of subjects during normal and abnormal labor. The radioiodination of oxytocin was done by adding 10 μg of oxytocin to 1 mCi carrier-free $Na^{131}I$. To this mixture were rapidly added, in order, fresh chloramine-T, sodium metabisulfite, and potassium iodide solution as a wash. The mixture was stirred after each addition and then run through a Sephadex G-10 column, which was washed with potassium iodide solution. The column was eluted with 0.05M phosphate buffer at pH 8.6. The radioactivity of eluate fractions was counted. The specific activity was usually about 40 μCi/μg protein. The labeled protein and salt were separated using an Amberlite IRA 400 resin column. In the assay method 10 mμg of ^{131}I-oxytocin was added to 0.5 ml of serum, to which rabbit antihuman γ-globulin was added after 2-hr incubation. The ^{131}I-labeled antigen-antibody precipitate was counted. Serum samples obtained from 35 subjects who had never received oxytocin, 74 subjects who had oxytocin-induced labor, and 58 subjects who had abnormal labor and had been treated with intravenous oxytocin to stimulate labor, revealed no oxytocin antibodies in any instance. (BBB)

19286 CHEMICAL STUDIES ON THE CAUSE OF BIOLOGICAL RADIATION INJURIES. Fahr, Egon; Gattner, Hans; Doerhoefer, Guenther; Kleber, Rolf; Doenges, Karl-Heinz; Loesche, Bernd; Popp, Heinrich; Boebinger, Elga (Institut fuer Organische Chemie der Univ., Germany). Ber. Phys.-Med. Ges. Wuerzburg, 72: 40-6(1966). (In German).

The effect of uv radiation on the components of nucleic acids are described in detail. Methods of chemical modification of ribosyl phosphoric acids, cytosine, cytidine, cytidylic acid, and other compounds are outlined. Properties of the radiation products of these compounds are described and discussed. The chemical effects of radiation on uracil to form dimeric uracil is detailed by structural formulae. Effects of radiation on uridine phosphates are described. Results of studies on the effect of ionizing radiation on aqueous solutions of uracil, thymine, and cytosine, using a dose rate of 300 kR/min for 2 to 3 min is reported. Thymine was transformed into a mixture of cis- and trans-thymine glycol. Cytosine yielded a solution whose extinction coefficient slowly increased into the range of 260 mμ; this indicated intermediate formation of cytosine glycol, unstable uracil glycol, and finally, isobarbituric acid. Uracil did not yield isobarbituric acid, as expected, but instead a product of undetermined structure that did not have an extinction coefficient at 260 mμ and that changed back to form uracil. It was concluded that the radiochemical modification of cytosine to form isobarbituric acid could lead to formation of a uracil derivative in DNA and that this effect might be related to radioinduced mutations. (BBB)

19287 EFFECT OF IODINATION OF ANTIFIBRINOGEN ANTIBODIES WITH RESPECT TO PRECIPITATING AND ABSORPTION ACTIVITIES. Fritz, R. B.; Lassiter, S.; Day, E. D. (Duke Univ., Durham, N. C.). Immunochemistry, 4: 283-93(Sept. 1967).

The effect of radioiodination on antibody activity was studied in the fibrinogen-antifibrinogen system, the 2 components being labeled with ^{131}I and ^{125}I respectively. Radioiodination of γ-globulin fractions was carried out as follows: to 0.5 ml 1N HCl was added

the required amount of carrier iodide as KI in 0.25 ml to give the desired number of iodine atoms per protein molecule. Then ^{125}I in 0.025 ml solution was added, followed by 0.25 ml 0.02M $NaNO_2$. The resulting iodine was neutralized and buffered by the addition of 0.5 ml borate buffer (pH 8), and 0.5 ml 1N NaOH and was added dropwise to 12 to 20 ml samples of γ-globulin dissolved in 1 ml borate buffer. The antiserum globulin was labeled with ^{125}I such that 1 mg (0.5 ml) registered about 150,000 cpm. Fibrinogen was labeled with ^{131}I such that the amount of it precipitated at equivalence with 1 ml of antiserum globulin would contain 20,000 cpm ^{131}I. The radioiodinated globulins were tested for ability to be precipitated by porcine fibrinogen and to be adsorbed by porcine fibrin. At each iodination level, loss of precipitating activity in a given antiserum globulin was comparable to loss of adsorbing activity. It was concluded that the effect of radioiodination upon the precipitating activity of antibodies was primarily upon binding rather than upon aggregation. The binding of antibodies to certain antigenic determinants of fibrinogen was very sensitive to radioiodination but relatively insensitive to other determinants. (BBB)

19288 THE ROLE OF THE THYMUS IN EXPERIMENTAL MOUSE AMYLOIDOSIS. Ranlov, Poul (Univ. of Copenhagen). Acta Pathol. Microbiol. Scand., 67: 42-54(1966).

The effects of thymectomy and/or sublethal (400-R) x irradiation on the induction of experimental caseinate amyloidosis in adult C3H mice were investigated. Serum protein electrophoretic studies were carried out. Mice previously subjected to thymectomy or combined thymectomy-irradiation developed amyloidosis considerably more rapidly and to a greater extent than control animals subjected to sham-thymectomy alone or combined sham-thymectomy and irradiation. In addition, thymectomized animals showed a mortality of 25% during the caseinate treatment, while the survival in the sham-thymectomized groups was 100%. No spontaneous amyloidosis was observed in a control series of mice not receiving caseinate treatment. A negative correlation was noted between the ability to increase the number of lymphocytes (thymus-dependent) and the degree and severity of the induced amyloidosis; the actual amount of lymphoid tissue present was not important. It was suggested that thymectomy tended to promote the development of amyloid disease, possibly through the elimination of the role of the thymus in regulating protein synthesis in mesenchymal tissue. In the absence of the thymus, even brief antigenic stimulation could lead to a breakdown of mesenchymal tissue function with subsequent deposition of amyloid. (BBB)

19289 CLINICAL STUDIES OF THE THYROID DISORDERS WITH SPECIAL REFERENCE TO THE THYROID AUTOANTIBODIES. II. EFFECT OF TREATMENT WITH ^{131}I ON THE CHANGES OF AUTOANTIBODIES OF HYPERTHYROIDISM. Hara, Masao (Niigata Univ., Japan). Nippon Naibumpi Gakkai Zasshi, 42: 1000-7(Dec. 1966). (In Japanese).

The sera of patients with hyperthyroidism before and after ^{131}I therapy were examined for circulating thyroid autoantibodies; red cell hemagglutination and microsomal complement fixation tests were used. A transient fall in thyroglobulin antibody titer and in microsomal complement fixation antibody titer were observed after treatment in the patients who had autoantibody in the serum before treatment. Microsomal complement fixation antibody titer increased sooner after the initial decrease than did the thyroglobulin antibody titer. A remarkable increase of microsomal complement fixation antibody was seen two to four months after therapy; the thyroglobulin antibody increased at six to eight months. These changes in autoantibody titers indicated that thyroglobulin may leak into the blood after therapy with ^{131}I. The transient fall in autoantibody titers after treatment was explained on the basis that an antigen antibody reaction in vivo and the contact between thyroglobulin or intercellular microsomal components and the antibody-producing cells provoked the formation of new autoantibodies. No correlation was found between thyroid autoantibody titer before treatment with ^{131}I, or the change of autoantibody titer after treatment, and the initial effect of treatment with ^{131}I. The occurrence of hypothyroidism after treatment could not be foreseen from the autoantibody titer prior to therapy. A high incidence of autoantibody was found especially in cases where hypothyroidism developed after late treatment. (NSA of Japan)

19290 FLUORESCNECE OF CAROTENOIDS. Wolf, F. T.; Stevens, M. V. (Vanderbilt Univ., Nashville). Contract AT (40-1)-2825. Photochem. Photobiol., 6: 597-9(Sept. 1967).

The uv-induced fluorescence of the carotenoids, β-carotene, lutein, lutein epoxide, and violaxanthin was studied. All are fluorescent compounds, upon excitation at ~280 mμ, at wavelengths close to those of their uv absorption maxima. β-Carotene, which is typical of carotenoids in general, had an absorption spectrum (in petroleum ether) with peaks at 425, 451, and 482 mμ in the visible region, and a peak at 270 mμ (in hexane) in the uv. Experiments with several carotenoids isolated from wheat indicated fluorescence in the range 300 to 400 mμ, with an excitation maximum around 270 mμ. With lutein epoxide the excitation beam case had a wavelength of 285 mμ and a dispersion of ±5 mμ. Fluorescence has observed throughout the range 300 to 380 mμ with a maximum between 320 and 335 mμ. Little variation was found with the other xanthophylls or the carotene samples examined. Fluorescence of all samples occurred within the limits 300 to 400 mμ, with maxima between 320 and 340 mμ. All samples were scanned throughout the visible spectrum. No fluorescence was observed above 400 mμ. Upon excitation of the carotenoids at 450 mμ, that corresponds closely to their maximum absorption in the visible region, no fluorescence was seen. (BBB)

19291 UPTAKE OF RADIOSTRONTIUM BY GRAIN CROPS FROM THE SOILS OF THE GEORGIAN SSR. Kvaratskhelia, N. T.; Arnautov, G. N. Sov. Soil Sci. (Engl. Transl.), No. 3, 378-83(Mar. 1967).

The uptake of radiostrontium by plants was studied under different soil conditions to develop methods for reducing the entry of radiostrontium into plants. Nine soils were selected, all belonging to the principal zonal groups found in Georgia, USSR. The removal of ^{90}Sr from the plow layers of these soils was studied by pot experiments in which ^{90}Sr was added at a rate of 1 μCi/Kg of soil. Radioassay of ashed grain crops (barley and wheat) grown in the soil showed that the soils could be arranged in the following order of decreasing uptake of this nuclide by plants: Podzolic soil > Meadow-Alluvial sandy loam > Red Earth > Humic Calcareous > Chernozem > Solonetz > Gray Cinnamon-Brown soil. The order of this series was directly correlated with the content of water-soluble ^{90}Sr in the soils. Application of manure to the soil led to a sharp reduction in the uptake of radiostrontium by the plants. The magnitude of this effect was greater, the lower the content of humus in the soil. Addition of such nutrients to the soil as K and P reduced the accumulation of ^{90}Sr in the plants. Liming caused a sharp reduction in the removal of ^{90}Sr in soils that were not base-saturated, and the effectiveness of liming was higher in strongly acid soils. (BBB)

19292 EFFECT OF IRRADIATION IN VITRO ON MIXED LEUKOCYTE CULTURES AND ON LEUKOCYTE CULTURES WITH PHYTOHEMAGGLUTININ. Kasakura, S.; Lowenstein, L. (Royal Victoria Hospital, Montreal). Ser. Haematol., 11: 211-12(1965).

Normal human leukocytes were x irradiated in vitro with doses of 400 to 1500 R. Mixed leukocyte cultures were then prepared, in which cells from only 1 or both of the donors had been irradiated. Phytohemagglutinin (PHA) cultures were also prepared from each donor's irradiated and nonirradiated leukocytes. Irradiation of leukocytes from both donors with 400 to 800 R abolished the blastogenic effectiveness. However, leukocytes irradiated with 1000 or 1500 R were still able to stimulate blastogenesis when added to nonirradiated allogeneic leukocytes. The response to PHA was not inhibited by 400 or 600 R, and was only moderately reduced by 800 to 1500 R. It may be possible to apply this observation advantageously in donor selection for homotransplantation. Although PHA normally causes transformation of more than 70% of leukocytes in culture, it seems unusual that after 1500 R irradiation, PHA still causes significant synthesis of DNA. This observation requires exploration and could have important implications, particularly if a pure preparation of the mitogenic factor in PHA can be obtained. (BBB)

19293 EFFECTS OF IRRADIATED SUCROSE ON THE GROWTH OF VEGETABLE TISSUES AND OTHER BIOLOGICAL SYSTEMS. Bandiera, Milena; Morpurgo, Giorgio; Ricci, Roberta. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 42: 426-34(Mar. 1967). (In Italian).

Several biological systems were used to test the effects of γ-irradiated sucrose on growth inhibition. The irradiated sucrose produced a strong inhibition on the growth of cells of the wild carrot, Daucus carota. The growth of two strains of Escherichia coli K 12 was inhibited by irradiated sucrose, which also dramatically affected survival of the cells; a slight effect was noted on a third strain of E. coli; while a strain of Bacillus subtilis and Aspergillus nidulans showed no effect from irradiated sucrose. (auth) (TSS)

19294 PHOSPHORYLATION PROCESS IN COTTON MITOCHONDRIA AND NUCLEI UNDER NORMAL CONDITIONS AND DURING EXPOSURE TO γ RADIATION. Arslanova, S. V. (Inst. of Experimental Biology of Technical and Grain Cultures, Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 8, 44-7(1967). (In Russian).

Radiation effects on biosynthesis of ATP and hexosephosphoric acid in isolated mitochondria and nuclei of Gossypium herbaceum

were studied. Rootlets of C-1622 (late-ripening and radiosensitive) and 1306-DV (fast-ripening and less radiosensitive) strains were given 30 R/sec, 10 kr doses of γ radiation. Doses of 10 kr inhibited the formation of ATP in mitochondria and nuclei in both strains. However, the inhibition was more pronounced in the radiosensitive (C-1622) strain. The tabulated data show a faster rate of ^{32}P incorporation into the hexosephosphorylation process in the C-1622 strain. (R.V.J.)

19295 EFFECT OF X-RAY IRRADIATION ON THE GLUTAMATE DEHYDROGENASE ACTIVITY OF THE CENTRAL NERVOUS SYSTEM AND CARDIAC MUSCLE. Pikulev, A. T.; Traul'ko, T. V.; Demeneva, T. V. (Belorussian State Univ., USSR). Dokl. Akad. Nauk BSSR, 11: 457-9(1967). (In Russian).

Change in the activity of enzymes taking part in the glutamic acid metabolism was examined to help study the mechanism of ionizing radiation effects on this amino acid. The change in the activity of glutamate dehydrogenase was determined in different parts of the central nervous system and cardiac muscle exposed to 40 R x-ray dosage. Tissues of white male rats were examined 1 and 2 hr, and 1, 3, and 7 days after exposure. In the control group the highest intensity of oxidative deamination of glutamic acid occurred in the cardiac muscle, the lowest in the spinal cord, and fairly low activity took place in the gray and white matter of the brain. After irradiation the activity of the gray and white matter and cerebellum remained essentially unchanged except at 24 hours after exposure, when it was reduced to below 90% in comparison with the control. Maximum reduction of glutamate dehydrogenase activity in the spinal cord was observed 3 days after exposure (53.7%), and in the cardiac muscle 1 day after exposure (70.2%). It is therefore assumed that changes in glutamate enzyme activity play an important role in the course of radiation injury and help provide for compensation processes. This paper was presented by T. N. Godnev, Academician AN BSSR. Orig. art. has: 1 table. (ATD)

19296 CHANGE IN THE LIVER AND SKELETAL MUSCLE CHOLINESTERASE OF WHITE RATS UPON X RAY AND NEUTRON IRRADIATION. Khripchenko, I. P.; Gromyko, A. S. (Belorussian State Univ., USSR). Dokl. Akad. Nauk BSSR, 11: 455-6(1967). (In Russian).

The effect of relatively small doses of ionizing radiation on cholinesterase activity in various organs and tissues was examined to determine the role of enzymatic processes in pathological and compensation reactions in radiation sickness. While male rats were subjected to single total x-ray dosages of 40 R or neutron doses of about 13 rad, and the cholinesterase activity in the liver and skeletal muscle was determined one and five days later. The cholinesterase activity of skeletal muscle upon irradiation with either x rays or neutrons exceeded that of the control by more than 150%, while the activity of the liver did not appear to be significantly disturbed by small doses of ionizing radiation. It is indicated that changes in the muscle tissue may be associated with endocellular distribution of cholinesterase and with the nervous system's corresponding reaction to any stimulus. This paper was presented by D. A. Markov, Academician AN BSSR. Orig. art. has: 1 table. (ATD)

Ecology

Refer also to abstract 19348.

19297 (CEA-R-3306) RETOMBEES LOCALES ET CHAINE ALIMENTAIRE ANIMALE. (Local fallout and the Animal Food Chain). Prat, Georges; Mercier, Ferdinand-Jerome (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Nov. 1967. 96p. (In French). Dep.

The local consequences of fresh fallout, especially in the case of atmospheric nuclear explosions, are reviewed from the point of view of the internal contamination of the consumer of foodstuffs of animal origin. The edibility of foodstuffs derived from animals having grazed in the presence of fallout is evaluated both from the wholesome and radiotoxicological points of view. The contamination level of these foodstuffs is calculated as a function of the ground fallout, and of agronomical and ecological parameters for each radionuclide of the animal food chain. The internal exposure of the human consumer is calculated from this level as a function of the diet and of various parameters especially temporal. The equivalent dose to each critical organ, including the digestive tract is deduced from the burdens of each organ. From this a nutritional hygiene in the areas affected by fallout is obtained, in relationship to the activity levels fixed by the responsible authorities in exceptional circumstances. Criteria for these activity levels are given as function of the food rations. (auth)

19298 (COO-1156-23) ^{90}Sr LEVELS IN MULE DEER AND FORAGE PLANTS. Farris, G. C.; Whicker, F. W.; Dahl, A. H. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). May 15, 1967. Contract AT(11-1)-1156. 20p. (CONF-670503-27). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

Concentrations of ^{90}Sr were measured in mule deer bone and in eight forage species that were sampled over a four year period from the Cache la Poudre drainage in north central Colorado. Maximum levels of ^{90}Sr occurred in vegetation and yearling deer in 1963-64. Vegetation was collected from sampling points within each of the major plant communities utilized by deer. Summer forage plants were generally higher in ^{90}Sr levels than in those species available to the deer in winter. Several factors including time, location, and species were demonstrated to influence ^{90}Sr levels in plants. Age had considerable influence on ^{90}Sr levels observed in the deer. Comparisons were made on ^{90}Sr levels observed in the forage, rumen contents, and bone. Bone-diet observed ratios of 0.15-0.24 were calculated for juvenile deer. (auth)

19299 (NYO-3018-18) STUDIES ON THE PRODUCTIVITY OF VASCULAR HYDROPHYTES AND THEIR ROLE IN MINERAL CYCLING IN AQUATIC ECOSYSTEMS. Progress Report, January 1-December 31, 1967. Hartman, Richard T. (Pittsburgh Univ., Pa.). Jan. 15, 1968. Contract AT(30-1)-3018. 53p. Dep. CFSTI.

Elodea canadensis was used in studies on the relationship between light intensity and photosynthetic rates in vascular hydrophytes over full day periods. Two daily patterns related to photosynthetic efficiency were observed. One was bi-modal, resulting from a high ratio of productivity-to-light intensity values during early morning and late afternoon periods. The second pattern shows high efficiencies only during early morning periods. Rates of photosynthetic carbon fixation were measured by the radiocarbon tracer method used throughout the studies. Solar radiation values for particular time increments were calculated from pyrheliometer recordings. Greater photosynthetic efficiency was observed during early morning and late afternoon periods of the day regardless of the season of the year. An experiment was carried out to determine the influence of carbon availability on carbon fixation rates in Elodea. An infrared analyzer was used for the measurement of rates of photosynthetic carbon uptake by emergent aquatic plants. Studies on carbon dioxide recycling were conducted using several species of the genus Lemna. Experiments on the fate of newly synthesized carbon compounds were conducted using ^{14}C. The role of vascular hydrophytes in the cycling of mineral elements within aquatic ecosystems was studied. Atomic absorption spectrophotometry was used for analysis of calcium, iron, manganese, and zinc, and results are tabulated. The relationship between the distribution and availability of an element and the redox potential of the water and sediments was investigated using Myriophyllum exalbescens and Potamogeton crispus. Phosphorus-32 was injected into the substrate and after various time intervals shoots of the plants were removed and autoradiographs were made. A number of photographs of these are included. (H.L.W.)

19300 (ORO-2975-5) A STUDY OF THE GENETIC COMPONENTS OF GROWTH AND REPRODUCTION IN PEROMYSCUS POLIONOTUS, AS THEY ARE AFFECTED BY RADIATION, TEMPERATURE, SELECTION, AND THE INTERACTION OF THESE THREE FACTORS. Progress Report, February 1, 1967-February 1, 1968. Carmon, J. L.; Smith, M. H. (Georgia Univ., Athens). Contract AT(40-1)-2975. 21p. Dep. CFSTI.

Mice were divided into three groups: controls, those receiving 100 R, and those receiving 200 R of gamma radiation. Each of these groups was divided into three subgroups and maintained at temperatures of 60°, 75°, and 90°F. Further subdivisions were made according to low and high growth rates, and randomly bred groups. The randomly bred groups were divided into two subgroups according to diet, those fed laboratory chow, and those fed a mixture of laboratory chow and bird seed. A statistical analysis was done on data from all litters born from the fourth through the sixth generations, and detailed results are presented for: total litter weight, number of mice born, birth weight, seven day weight, 14 day weight, 21 day weight, 28 day weight, 35 day weight, 42 day weight, and adaptability to field conditions. (H.L.W.)

19301 USE FOR RADIOACTIVATION ANALYSIS IN RADIOECOLOGICAL STUDIES. Fourcy, A.; Fer, A.; Poret, C.; Neuburger, M.; Garrec, J.-P. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 119, 39-48(Oct. 1967). (In French).

The method of activation analysis by thermal neutrons was used to determine the content of stable Ba, Ca, Cs, K, La, Na, Rb, Sc,

and Sr in seven species of aquatic plants. The results are presented in tabular form. Another table shows the relation between the Ba, Cs, Na, and Sr contents of the seven plants and the contents of these elements in the pond water. Radioactive wastes in the environment are gradually diluted with stable elements; analysis of stable elements supplements classical methods of analysis utilizing radioactive tracers. (H.L.W.)

19302 ROLE OF PLANTS IN CONTINENTAL RADIOECOLOGY; THE CASE OF THE GRENOBLE SITE. Ozenda, P. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 119, 3-8(Oct. 1967). (In French).

A review of the principles relating to the methods of radioecology as compared with those of general ecology, and an outline of the research row being carried out in this field by the Plant Biology laboratories of the Centre of Nuclear Studies in collaboration with the Grenoble Science Faculty are presented. (auth)

19303 DISTRIBUTION OF A MIXTURE OF FISSION PRODUCTS IN A SMALL MODEL SIMULATING ECOLOGICAL CONDITIONS OF A STREAM. Gagnaire, J.; Chamel, A.; Lachet, B.; Magnaval, R. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 119, 9-26(Oct, 1967). (In French).

A mixture of dissolved salts of ^{85}Sr, ^{137}Cs, ^{144}Ce, was placed in a model made of freshwater and sediments only. The importance of the retention and the further salting out of the final equilibrium state is studied as also is the localization and concentration rate of radioelements in filamentous algae or in reeds that are growing in the same model. The disappearance of radioelements dissolved in the water is hastened by the presence of plants during the first weeks after the contamination with radioelements; but the ultimate balance between the radioelements in solid or liquid phase is not changed. (auth)

19304 ATTEMPT TO INTERPRET THE FLUCTUATIONS OF RADIOELEMENT CONCENTRATION IN BLACK POPLAR. Gagnaire, J.; Chamel, A.; Ferard, G.; Lachet, B. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 119, 27-37(Oct. 1967).

The black poplar is a characteristic plant associated with river banks. The effects of climatic, physiological and chemical factors on the localization and concentration of ^{45}Ca, ^{85}Sr, ^{106}Ru, ^{137}Cs, ^{144}Ce in poplar were studied. The variations of ^{40}K, ^{137}Cs concentrations are compared for leaves of poplar, willow, elder, reed; the concentrations are related to the species and the organ and are related to the different stages of the life cycle. The detection of ^{137}Cs pollution in air by measuring its concentration in leaves does not give an adequate check during entire vegetative season. (auth)

19305 SECOND NATIONAL SYMPOSIUM ON RADIOECOLOGY. Evans, F. C. (Univ. of Michigan, Ann Arbor). Nucl. Safety, 9: 138-43(Mar.-Apr. 1968).

The Second National Symposium on Radioecology provided an opportunity for interdisciplinary communication among a broad spectrum of scientists concerned not only with the problems of environmental contamination from radioisotopes and the consequent hazards to human and other life, but also with the use of radioactivity tracers as tools to ascertain the precise pathways and rates of circulation of materials in nature. (auth)

19306 A SUMMARY OF ECOLOGICAL EFFECTS OF NUCLEAR TESTING ON NATIVE ANIMALS AT THE NEVADA TEST SITE. Allred, Dorald M.; Beck, D. Elden; Jorgensen, Clive D. (Brigham Young Univ., Provo, Utah). Utah Acad. Sci., Proc., 42: 252-60(1965).

No abnormalities definitely attributable to the effects of radiation on the somatoplasm or the germ plasm of native animals at the Nevada Test Site were revealed. On the basis of ecological distribution in disturbed areas, differences were found in the species composition in areas where the biota were disturbed but not completely destroyed. Rodents of four species were more common in disturbed than in undisturbed areas. A large population of Perognathus parvus occurred in a community completely denuded of vegetation by nuclear testing 4 yr previously. Dipodomys ordii was most frequently found in disturbed areas, Reithrodontomys megalotis in disturbed areas only, and Dipodomys deserti entirely in areas that showed disturbances from nuclear testing. Following the underground detonation Sedan, that resulted in displacement of millions of tons of earth, few animals were found within 3000 ft of ground zero. Populations were drastically reduced between 3000 and 5000 ft, and beyond 5000 ft the animals were apparently not affected by the shock front and throw-out effects. There was no immediate movement of small mammals away from the area. Physical abnormalities noted included several instances of change of fur color and minor dermatitis. One Perognathus longimembris was found with fused toes, and a kangaroo rat was found with a spotted tail rather than the usual solid-striped condition. Following the Sedan detonation several P. longimembris with white fur and a blind, young jackrabbit were found. More reptile species and individuals were found in disturbed than in undisturbed areas, and four species were found in disturbed areas only. Sixteen insect species were found only in disturbed terrain. (BBB)

Genetics and Cytogenetics

Refer also to abstracts 19268 and 19376.

19307 (ORO-3092-15) GENETIC INVESTIGATIONS OF INDUCED MUTATION AT THE hv LOCUS IN OATS AND AT THE ddt LOCUS IN BARLEY. Annual Progress Report. Wallace, A. T. (Florida Univ., Gainesville). Dec. 1967. Contract AT-(40-1)-3092. 76p. Dep. CFSTI.

In Avena byzantina the hv locus controls reactions to the two pathogens Helminthosporium victoriae and Puccinia coronata. Seed stocks from 175 independently induced mutants expressing full resistance and from 40 leaky mutants expressing partial resistance to H. victoriae toxin were isolated and purified. Studies are being made on the genetic nature of these mutants and mapping the fine structure of the locus. To determine effects of H. victoriae toxin on plants, experiments were conducted on root growth bioassay techniques, effects of toxin on respiration rate, and loss of electrolytes from seedlings. Gamma-ray-induced resistant mutants were crossed to susceptible parents and the segregation ratios were found to be 3.4:1, with susceptibility being dominant. It was concluded that mutation reduced the transmissibility of the chromosome carrying it. Resistant mutants produced by gamma radiation are associated with chromosome aberrations. In studies on barley, the average ratio of gamma ray-induced chlorophyll deficiency mutations was found to be 4:1. In a test for possible allelic complementation between paired mutants the root lengths of F_2 seedlings were determined from crosses involving resistant mutants. Studies were conducted on identification and isolation of the critical chromosome carrying the hv locus. A total of 31 monosomes were collected for examination and analysis. Crosses were made between Avena sativa monosomes and A. byzantina and F_2 segregation ratios for susceptibility and resistance to H. victoriae toxin are tabulated. Leaky mutants were crossed to the parent cultivar and random crosses were made of the offspring. Frequency distributions of primary and secondary root lengths were made from representative F_2 populations indicating allelic complementation. (H.L.W.)

19308 (ORO-3260-2) GENETIC EFFECTS OF RADIATION: MAMMALIAN BEHAVIOR. Technical Progress Report, February 1967-February 1968. Furchtgott, Ernest (Tennessee Univ., Knoxville. Dept. of Psychology). Feb. 29, 1968. Contract AT(40-1)-3260. 8p. Dep. CFSTI.

Male mice were given 600 R of x rays spermatogonially or postspermatogonially. They were then mated and behavior of the offspring was studied. The offspring showed no aberrant motor reflexes, locomotor deficits, or changes in a test of fearfulness. In testing avoidance conditioning with electric shock as the unconditioned stimulus and a buzzer as the conditioned stimulus, offspring of both spermatogonially and postspermatogonially irradiated sires required more trials to reach a criterion of conditioning. The experimental groups also had a larger variance. (auth)

19309 (SU-326P7-194) REPLICATION, TRANSCRIPTION, AND REPAIR OF GENETIC MATERIAL. B. L. Report No. 194. Period Covered: March 1, 1962-June 1, 1967. Hanawalt, Philip C. (Stanford Univ., Calif. Biophysics Lab.). June 1967. Contract AT(04-3)-326-7. 49p. Dep. CFSTI.

The growing point region was isolated from the bacterial chromosome, and some of its physical and chemical properties were defined. A pronase-resistant complex containing the newly replicated fragments of DNA from Escherichia coli were separated from the bulk of DNA fragments and cell debris by zone sedimentation in sucrose shelf gradients. The entire replicating chromosome from Mycoplasma laidlawii B was isolated by CsCl density gradient equilibrium sedimentation. Evidence was obtained that the messenger RNA transcription event that supports the basal levels of inducible enzymes occurs as the DNA replicates in the E. coli strain TAU bar. Studies on the nitrosoguanidine action in E. coli indicated that the mutagenic effect was principally at the growing point in the DNA. This work also supported the notion that amino acid starvation does align chromosomal replication cycles at a fixed genetic site in the E. coli strain TAU bar. Direct evidence was obtained for the non-conservative, repair replication of damaged DNA in E. coli, in Mycoplasma laidlawii, and in Tetrahymena pyriformis. In E. coli repair was observed following treatment of cultures with ultraviolet light, nitrogen mustard,

and nitrosoguanidine. Studies on the variation in ultraviolet sensitivity with the DNA replication cycle in bacteria indicated that such variations could be explained entirely on the basis of dark repair phenomena and the necessity of completing repair-replication before the attempted normal replication of DNA. It was shown that E. coli exhibits a greater selectivity for thymine over the analogue, 5-bromouracil, in repair replication than in the semi-conservative mode of DNA replication, indicating that different enzyme systems may be involved. A temperature-sensitive DNA replication deficient mutant was found to be capable of repair replication of ultraviolet damaged DNA at the restrictive temperature, as further evidence for separate identities of the repair and normal replication systems. Principal and satellite DNA components from Euglena gracilis were isolated and characterized. Evidence supported an autonomous genetic role for one of the satellite DNA species in the replication of chloroplasts and an association of the other with mitochondria. It was shown that in the slime mold, Physarum polycephalum, the satellite density mitochondrial DNA species was replicated throughout the entire growth cycle whereas nuclear DNA synthesis was completed within the first half of the intermitotic period. Mitochondrial DNA from Tetrahymena pyriformis was found to have the same density as the nuclear DNA components in this system. (H.L.W.)

19310 CONTROL OF DARK REPAIR MECHANISMS IN MEIOTIC CELLS. Davies, D. Roy (Atomic Energy Research Establishment, Berks, Eng.). Molec. Gen. Genet., 100: 140-9 (1967).

The responses to uv irradiation of pre-meiotic and meiotic cells of the unicellular green alga Chlamydomonas reinhardi were examined in a wild type and a uv-sensitive mutant (UVS 1) strain. During late interphase and early prophase the cells become highly sensitive to uv under dark conditions, but show much less change in sensitivity following photoreactivation (PR). At these times the effect of PR is not dose-modifying, but very large PR factors are obtained, at the 50% survival level in some stages values up to 23 being obtained. The enhancement of dark sensitivity is attributed to a diminution in dark repair activity, and it is suggested that this is associated with the process of genetic recombination that occurs in these meiotic cells. In addition at those times when the dark repair capacity is at a low level, a phenomenon akin to uv reactivation occurs, in that within a certain dose range, survival increases with increasing dose. The possible basis of this phenomenon is discussed. (auth)

19311 UV-INDUCED ENHANCEMENT OF RECOMBINATION AMONG LAMBDA BACTERIOPHAGES IN UV-SENSITIVE HOST BACTERIA. Baker, Raymond M.; Haynes, Robert H. (Univ. of California, Berkeley). Mol. Gen. Genet., 100: 166-77(1967).

The uv enhancement of recombination among λ bacteriophages was studied in host bacteria that are defective in DNA repair and compared to that observed in wild type host strains. The following conclusions were drawn: The uv enhancement of recombination is even greater in HCR^- than in HCR^+ host strains. The uv lesions that promote recombination are repaired by host cell reactivation with the same efficiency as are potentially lethal uv lesions. The uv enhancement of λ recombination is the same in HCR^+ host strains that are deficient in their own recombination as it is in wild type hosts. Very few lesions per phage particle are sufficient to stimulate the enhanced recombination. The uv-stimulated recombination occurs during the same time interval as host cell reactivation. There is substantial multiplicity reactivation of uv lesions in λ. Similar numbers of recombination events neutralize similar numbers of uv lesions in HCR^+ and HCR^- hosts, but a much greater survival increase is observed in the latter. (auth)

19312 SPECIFICITY IN THE PHOTOREACTIVATION OF PREMUTATIONAL DAMAGE INDUCED IN NEUROSPORA CRASSA BY ULTRAVIOLET. Kilbey, B. J. (Medical Research Council, Edinburgh). Mol. Gen. Gent., 100: 159-65(1967).

Photoreactivation of the events that lead to ultraviolet-induced reversion of sixteen mutants was studied. Reversion of one mutant, the inositol allele 37401, is photoreactivated far less than lethal damage. Reversion of the remaining 15 mutants, alleles at three different loci, is photoreactivated to the same extent as lethal damage. Various explanations of this finding are considered and the implications of repair specificity in modifying mutagen specificity are discussed briefly. (auth)

19313 GROWTH OF AUSTRIAN AND SCOTS PINE PLANTS AFTER GAMMA-IRRADIATION OF POLLEN. Vidakovic, M. (Forestry Faculty, Zagreb). Radiat. Bot., 7: 529-42(Dec. 1967).

Intraspecific hybridization was carried out with irradiated pollen. In both species one pair of parent trees was used, with one exception in Austrian Pine, where the conelets of the pure control were damaged and plants from open pollination were taken for the control. The irradiation exposures applied to the pollen of Austrian Pine were 0.05, 0.2, 0.5, 1, 1.5, 3, 5 and 10 kR. Pollen of Scots Pine was irradiated with 0.05, 0.075, 0.1, 0.15, 0.2, 0.25, 0.3, 0.4, 0.5, 0.75, 1.0, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 6, 7, 8, 9, and 10 kR. The source of the gamma rays was a 1200 Ci ^{60}Co source. The measurements of heights and diameters were taken after the third and fourth growing periods. Plants of Scots Pine produced, through controlled pollination with the γ-irradiated pollen, after the third and fourth growing periods, greater heights and diameters than controls (plants whose gametophyte of the male parent was not irradiated). In Austrian Pine statistically significant differences were obtained for the heights of 3- and 4-year old plants compared with their controls, while for the diameters no statistically significant differences in 4-year old plants were obtained. In both species variability increased with increasing exposure. Growth stimulation was more evident in both species after higher exposures. Exposures below 100 R did not produce stimulation. The results obtained favour Osborne's hypothesis, i.e., that the use of irradiated pollen causes an increase in the number of heterozygotic plants and that the induction of heterosis is possible. (auth) (UK)

19314 EFFECTS OF VARIOUS γ-RAY DOSE RATE ON THE INCIDENCE OF CHROMOSOMAL ABERRATIONS IN LIVER CELLS OF MAMMALS. Nuzhdin, N. I.; Kurnishkov, I. S. Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 257-645(1965). (In Russian).

The study of chromosomal mutation rates (acentrical fragments and dicentric chromosomes) in liver cells with high metabolic activity and a low mitotic index (in mice) showed that with equal amounts of ionizing radiation (300 R) the degree of radiation injury to the nuclear structures of the cells was higher with a high dose rate (269 R/min to 304 R/min), than with a low dose rate (6.7 R/min to 8 R/min). The effect of the dose rate was mainly determined from variations in the incidence of chromosomal aberrations of the dicentric chromosome type. The exposure to ionizing radiation within the dose rates utilised resulted in lasting injuries irreversible in time (up to six months after irradiation). (auth)

19315 GENETIC EFFECTS OF INTERMEDIATE NEUTRONS. I. THE DELETION FREQUENCY AND FERTILITY IN DROSOPHILA MELANOGASTER. Panikovskaya, L. I.; Troitskii, N. A. (Inst. of General Genetics, Moscow. Inst. of Genetics and Cytology, Minsk). Genetika, 4: 15-20(Jan. 1968). (In Russian).

The effects of intermediate neutrons of the average energy 200 KeV at a dose of 200 rad and radiation dose rate 78 rad per hour on the deletion frequency in the X chromosome of Drosophila males and on their fertility at different stages of spermatogenesis were studied. The effect of intermediate neutrons was compared to that of gamma rays and fast neutrons (according to the data of the other investigators). It was established that the effect of intermediate neutrons was similar to that of gamma rays; in both cases the greatest deletion frequency occurred in spermatocytes. Intermediate neutrons proved to be more effective than gamma rays at the most radiosensitive stages (spermatids, and spermatocytes). Mature sperm and spermatogonia probably have about the same sensitivity to intermediate neutrons and to gamma rays. Intermediate neutrons proved to affect the fertility differently from gamma rays and fast neutrons. Instead of an abrupt decrease of fertility in the 5 to 8 days after the irradiation and an increase in 9 to 12 days, as was observed for gamma rays and fast neutrons, the fertility gradually decreased from 1 to 12 days after irradiation by intermediate neutrons; a similar decrease was observed in the controls. (auth)

19316 ON THE DURATION OF THE PERSISTENCE OF POTENTIAL DAMAGES OF CHROMOSOMAL STRUCTURE INDUCED BY RADIATION. Protopopova, E. M.; Shapiro, N. I. (Inst. of General Genetics, Moscow. Kurchatov Inst. of Atomic Energy, Moscow). Genetika, 4: 5-14(Jan. 1968). (In Russian).

The purpose of the experiments was to determine how long the potential chromosomal damages induced in dry seeds by x rays can persist. By means of the C-mitosis technique the potential chromosomal changes were detected in the second cell generation after the irradiation. This means that these changes persist through all the stages of one cell cycle and can go through mitotic division. (auth)

19317 EFFECT OF GAMMA RAYS AND FAST NEUTRONS ON THE FREQUENCY OF CHROMOSOME REARRANGEMENTS AND ON THE SURVIVAL OF POTATO SEEDLINGS. Tarasenko, N. D. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Genetika, 4: 28-32(Jan. 1968). (In Russian).

It was shown that gamma rays affect the cell structures more

drastically as compared to the equivalent doses of fast neutrons, decreasing the survival of seedlings. The death-rate among the seeds irradiated after six years' storage was much higher after the irradiation with gamma rays, as compared to the dose of fast neutrons resulting in the same frequency of chromosome rearrangements. It is assumed that the more drastic effect of gamma rays on the cell structures results in the liberation of the hydrolytic enzymes of lysosomes. The superimposition of the effects of ageing and gamma-rays was observed in the seeds irradiated after six years storage. When the seeds that have been stored for several years are irradiated with small LDE for the purpose of obtaining mutations, lower doses should be used, considering that the radiosensitivity increases with the increasing duration of storage. (auth)

19318 GENETIC ANALYSIS OF THE EXTENT AND TYPE OF FUNCTIONAL INACTIVATION IN IRREPARABLE RECESSIVE LETHAL MUTATIONS IN THE ad-3 REGION OF NEUROSPORA CRASSA. de Serres, F. J. (Oak Ridge National Lab., Tenn.). Genetics, 58: 69-77(Jan. 1968).

Homology tests were made on a selected sample of ad-3 (adenine-3) mutations classified on the basis of trikaryon tests with strain 12-1-18, which carries a deletion of the ad-3 and immediately adjacent regions. This sample included 13 reparable recessive lethal mutations and 51 irreparable recessive lethal mutations in the ad-3 region, and homology tests were made to determine the extent and type of genetic damage in individual strains. These tests showed that two of 18 mutations originally classified as irreparable ad-3A, and two of 31 originally classified as irreparable ad-3B, were actually ad-3 point mutants having closely linked recessive lethal damage. The closely linked lethal mutation in one of these strains is located between the ad-3A and ad-3B loci. Since this mutation is irreparable on complete medium, this discovery provides evidence for the presence of at least one gene with an indispensable function in this region. The homology tests have demonstrated that there is a difference in extent of functional inactivation between irreparable and reparable ad-3 mutations. This observation is consistent with the interpretation that ad-3 mutations result from multilocus deletion. (auth)

19319 ULTRAVIOLET-INDUCED GENETIC RECOMBINATION IN A PARTIALLY DIPLOID STRAIN OF ESCHERICHIA COLI. Curtiss III, Roy (Oak Ridge National Lab., Tenn. Univ. of Chicago). Genetics, 58: 9-54(Jan. 1968).

Small doses of uv radiation induce haploidization in a partially diploid strain of Escherichia coli K-12. The frequency of all recombinant types among survivors increased linearly up to a dose of 500 ergs/mm^2, and at 1200 ergs/mm^2, 75% of the survivors were recombinants. Plating cells immediately after exposure to 300 ergs/mm^2 resulted in pure clones of haploid recombinants, pure clones of homozygous partially diploid recombinants, and mixed clones containing equal numbers of haploid recombinants and partially diploid cells. Experiments are described that were designed to reveal the cytological and molecular events following ultraviolet irradiation. A model to explain the results is proposed. (M.M.B.)

19320 ETHYLENIMINE EFFECTS ON THE DEVELOPMENT AND MUTATIONS IN FAST-NEUTRON-IRRADIATED BARLEY SOWN UNDER VARIOUS ECOLOGICAL CONDITIONS. Shangin-Berezovskii, G. N. Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 69-80(1965). (In Russian).

Experiments on pre-sowing treatment of barley seeds with 0.01% solution of ethylenimine for 4 hours have revealed the modifying action of the latter on the effects of radiation with fast neutron. Depending on the conditions of growing M_1 plants the treatment with ethylenimine either enhanced or weakened the damaging effects of irradiation, which could be detected from development indices in M_1 plants and the chlorophyll mutations in M_2 plants. (auth)

19321 SELECTIVITY OF SPROUTING AND RATE OF CHLOROPHYLL MUTATIONS. Shangin-Berezovskii, G. N. Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 81-93(1965). (In Russian).

The sprouting of M_2 barley seeds exposed in its previous generation to gamma- and fast-neutron irradiation, at a relatively low (6 to 9°C) and high (26°C on an average) temperature revealed the different spectrum and different rates of chlorophyll mutations. The relatively low level of variability at the high temperature, however, could not be explained by negative selection only. The results of field experiments coupled with the present data suggested that depending on conditions of M_2 sprouting there occurred both negative and positive selection of changes as well as recovery proprocesses in the seeds. (auth)

19322 THE EFFECTS OF 5-FLUORODEOXYURIDINE ON RADIATION-INDUCED CHROMATID ABERRATIONS IN TRADESCANTIA MICROSPORES. Strickland, Priscilla Love. Atlanta, Emory Univ., 1967. 70p.

Thesis.

The hypothesis that DNA synthesis is involved in radiation induced exchange formation was tested in inflorescences of Tradescantia paludosa pretreated in solutions of 5-fluorodeoxyuridine (FUDR). Metaphase chromosomes were scored to obtain the aberration frequencies for chromatid breaks, isochromatid breaks, and chromatid exchanges and P values between means were calculated using a Likelihood Ratio chi square test. Results indicated that the FUDR effects obtained were due to the limitation of thymidylate and that some type of DNA repair is involved in exchange formation. (Disser. Abstr.) (TSS)

Health Physics and Safety

Refer also to abstracts 18734, 18968, 19226, 19297, 19298, 19363, 19370, 19436, 19450, 19470, and 20569.

19323 (A/AC.82/G/L-1185) TSEZII-137 V ORGANIZME ZHITELEI G. MOSKVY. (^{137}Cs in the Organisms of the Inhabitants of Moscow). Marei, A. N.; Stolyarov, V. P.; Styazhkin, V. M.; Gerasimova, M. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1967. 5p. (In Russian). Dep.

A brief account is given of the ^{137}Cs content of a sample of the Moscow population according to age and sex during the winter season of 1966-67. Results obtained for 118 men and 154 women, up to 60 yr of age, and 71 children showed that the ^{137}Cs content of men was 1.4 to 1.8 times higher than the content of women. However, the highest level of ^{137}Cs was found in children between 11 and 20 yr of age. The absolute uptake of ^{137}Cs in the population examined was 10 to 20 times less than the maximum permissible dose. (R.V.J.)

19324 (AERE-R-5679) THE POINT SOURCE METHOD OF DOSE CALCULATION IN MEDIA OF VARYING DENSITY WITH SPECIAL REFERENCE TO β PARTICLES. Whitehouse, W. J. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1968. 22p. Dep. CFSTI. UK 3s. 6d.

The point source method was adapted to calculation of the energy deposition in media of varying density, and is discussed with special reference to the dose from β particles in trabecular bone. The dose reciprocity theorem is re-stated, in a form consistent with the density-dependent point source formula. The Loevinger point source formula for β rays is used to solve two models; alternating infinite slabs of different substances, and a hollow sphere filled with one substance, and surrounded by another. The numerical values used in these solutions correspond to the bone-seeking nuclides ^{90}Sr, ^{90}Y, and ^{32}P, and to substances with the density and mean composition of trabecular bone. The solutions indicate that the mean dose in trabecular bone is not markedly different from that which would be calculated on the assumption that the bone and marrow are intimately mixed. (auth)

19325 (BNL-50073) DOSE-EFFECT MODIFYING FACTORS IN RADIATION PROTECTION. Report of Subcommittee M-4 (Relative Biological Effectiveness) of the National Commission on Radiation Protection. (Brookhaven National Lab., Upton, N. Y.). Aug. 1967. 34p. Dep. CFSTI.

Recommendations of the National Commission on Radiation Protection Subcommittee on Relative Biological Effectiveness on dose-effect modification factors to be used in practical radiation protection are presented. It was deemed desirable to characterize an individual's entire cumulative exposure status by a single number. To do this, it is necessary to extend the present methods for summing exposures so that the incremented dose-equivalent values can be summed for all types of external and internal irradiations. To achieve this goal, a new system was devised for evaluating, summing, and recording occupational exposures. It is recommended that the risk from all radiation exposures be expressed relative to that from a basic whole-body exposure to a standard low-LET radiation, and that ^{60}Co gamma be designated as this standard low-LET radiation. The risk from any exposure is related to that from whole-body exposure to the standard radiation through an effectiveness factor (ef). This correction factor for external radiation is the product of several subfactors, including radiation quality, body region irradiated, and penetrating power. The product (dose in rad × ef), the dose equivalent, is expressed in terms of exposure record units (eru), analogous to the rem. It is also recommended that ef values be established for internal emitters, in order that the risk from known body burdens of internal emitters relative to that from external radiation can be represented in the cumulative eru

record. Recommendations on how to accomplish this, and representative suggested ef values, are given. (C.H.)

19326 (BNWL–665) EVALUATION OF RADIOLOGICAL CONDITIONS IN THE VICINITY OF HANFORD, JANUARY–JUNE 1967. Essig, T. H. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1968. Contract AT(45-1)-1830. 23p. Dep. CFSTI.

Surveillance of the Hanford environs during the first half of 1967 showed that the concentrations of radioactive materials in the vicinity were well within the appropriate limits and that radioactive wastes were under sound and continuous control. Most of the environmental radiation dose for the majority of persons living in the Hanford environs was due to natural sources and world-wide fallout rather than to Hanford operations. The major source of low-level radioactive waste released to the environment from Hanford plants is reactor cooling water discharged to the Columbia River, and ^{32}P continued to be the radionuclide of Hanford origin that contributed the largest radiation dose to individuals who consistently ate sizable quantities of locally caught fish. To estimate the maximum radiation dose received by persons residing in the Hanford environs, a hypothetical Maximum Individual was postulated. Included in this individual's annual diet were 200 meals of Columbia River fish. The Maximum Individual's estimated intake of ^{32}P from fish for the 12 month period ending June 30, 1967, was about 6% of the Maximum Permissible Rate of Intake (with bone as the critical organ). Generally, ^{131}I concentrations in the Hanford environs were at very low levels during the first half of 1967. The estimated thyroid dose for a small child (2 g thyroid) drinking Richland water for the 12 month period ending June 30, 1967, was 13 mrem, or 3% of the appropriate limit, as compared to 35 mrem during 1966. Radioactive fallout caused a brief increase in ^{131}I concentrations in the environment during January, but concentrations soon returned to the low levels experienced during most of 1966. (C.H.)

19327 (BNWL–SA–1601) BASES FOR ENVIRONMENTAL SURVEY DESIGN. Honstead, J. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 4, 1968. Contract AT(45-1)-1830. 11p. (CONF-680108–6). Dep. CFSTI.

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga.

The objectives of an environmental surveillance program are outlined and considered for designing a radiation protection program for nuclear installations. (W.H.K.)

19328 (COO–1500–5) RADON PROGENY INHALATION STUDY AS APPLICABLE TO URANIUM MINING. Third Annual Progress Report, January 1–December 31, 1967. (Colorado State Univ., Fort Collins). Feb. 29, 1968. Contract AT(11-1)-1500. 236p. Dep. CFSTI.

Major objectives of the research were development of a personal monitoring system and evaluation of respiratory protective devices. Measurements of airborne contaminants were made in the Schwartzwalder uranium mine near Golden, Colorado. Radon gas concentrations were determined using grab sampling flasks internally coated with zinc sulfide powder as a scintillator, and radon progeny concentrations were analyzed using membrane filter samples. The alpha spectrometry method allowed RaA and RaC on the filter to be separately determined and the resulting data were converted to RaA, RaB, and RaC concentrations at the time of sampling by computer techniques. The effective particle size distributions of the radon progeny were studied by diffusion tube sampling methods. A correlation between diffusion coefficients and atmospheric water content was observed. Measurements of the quantities and distributions of radon progeny deposited in the human respiratory tract were made with an in vivo gamma-ray detector contained in a shadow shield located in a field laboratory. A personal monitoring system for determining an individual miner's exposure to airborne radon progeny was developed. The system utilizes a lithium fluoride thermoluminescent dosimeter in conjunction with a personal, battery powered air sampler. A description of the system and experimental results obtained thus far are presented. Samples of urine, feces, blood, cranial hair, and whiskers were routinely obtained from uranium miners. Correlations of bioassay data with the best estimates of inhalation exposures to radon progeny were performed. Blood and facial hair appeared to be the most promising bioassay media for evaluating individual exposures. A study was undertaken to determine whether or not filter-type respirators would be effective against radon progeny inhalation under mining conditions. The filter cannisters were first tested for radon progeny removal efficiency and for air flow resistance in mine atmospheres. The actual effectiveness of the various respirators was then evaluated by measuring the deposition of radon progeny in the respiratory tract of a miner wearing the respirator while actually working. (H.L.W.)

19329 (IN–1041) THE IDAHO NUCLEAR CORPORATION SAFEGUARD REVIEW COMMITTEE. Nertney, R. J. (Idaho Nuclear Corp., Idaho Falls). Dec. 1967. Contract AT(10-1)-1230. 6p. Dep. CFSTI.

A brief outline of the operating modus of the committee is presented. The following points are considered: committee membership; duties and responsibilities; relationship to other committee and surveillance functions; relationship to line organization; committee meetings; content of the committee report, action regarding committee recommendations; followup on committee action; and committee inputs. (H.L.W.)

19330 (NP–17180) NORMES DE BASE RELATIVES A LA PROTECTION SANITAIRE DE LA POPULATION ET DES TRAVAILLEURS CONTRE LES DANGERS RESULTANT DES RADIATIONS IONISANTES. (Fundamental Standards Relative to the Sanitary Protection of the Population and Laborers from the Hazards Resulting from Ionizing Radiation). (European Atomic Energy Community). June 1967. 42p. (In French). Dep.

The radioprotection standards established by the European Atomic Energy Community are presented. The radioprotection concepts are defined and the areas of application of the standards are given. The maximum permissible doses for professionally exposed personnel are given. A table is presented showing maximum permissible concentrations of radioisotopes in drinking water and inhaled air of professionally exposed personnel. (J.S.R.)

19331 (NP–17202) DOZIMETRICHESKIE KHARAKTERISTIKI INKORPORIROVANNOGO MEZOTORIYA-228. (Dosimetric Characteristics of Incorporated Mesothorium-228). Malykhin, V. M.; Shamov, V. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1967. 22p. (In Russian).

A method was developed for the determination of the dosimetric characteristics of incorporated mesothorium-228. In the method adequate variants of the exchange model of the $^{228}MsTh \rightarrow {}^{228}RdTh$ were used based on the power function of retention (with the parameters of ^{226}Ra) for mesothorium-228 and exponential variant for ^{228}Th. The mathematical part of the method for the determination of the dosimetric characteristics of the chain $^{228}Ra \rightarrow {}^{228}Th$ was given. The quantitative characteristics of the accumulation-storage conditions, detection of the decay products, and the irradiation dose to the local tissues were derived for different durations of its uptake into mammals. The results are shown graphically. The dosimetric parameters and the general characteristics of indirect methods of tissue dosimetry were determined. A method is given for the determination of the dose received with time from the uptake of mesothorium-228 or by the combined uptake of ^{228}Ra and mesothorium-228. The characteristics of different methods for the dosimetry of incorporated mesothorium-228 are compared. The maximum permissible dose of mesothorium-228 for limited contact time in man was determined. (J.S.R.)

19332 (ORNL–4086) ESTIMATION OF RADIATION DOSES FOLLOWING A REACTOR ACCIDENT. Binford, F. T.; Barish, J.; Kam, F. B. K. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 41p. Dep. CFSTI.

Based upon the "Gaussian Plume" formula, a model has been developed which permits calculation of the downwind radiation doses to be expected following a reactor accident. Although the calculation presented here is concerned only with the thyroid dose due to iodines and the whole body dose due to iodines and noble gases, it can easily be adapted to handle other radioisotopes. The basic assumptions include instantaneous release of a given quantity of radioactive material into a reactor building followed by emission at a constant (volume) rate from a point source. Radioactive decay both within the building and during passage downwind are accounted for as are the growth and decay of daughter products and the effects of physical separation such as filtration. A Fortran IV computer program "PLUME" has been written for the purpose of solving the equations developed. (auth)

19333 (TID–23992) SAFETY GUIDELINES FOR HIGH ENERGY ACCELERATOR FACILITIES. (National Accelerator Safety Committee). 1967. 33p. Dep. GPO $0.30.

Guidelines are suggested relating to management, buildings and facilities, equipment design, and procedures. Radiation protection and electrical safety guidelines are treated only in a peripheral manner. (W.H.K.)

19334 CONTROL OF RADIATION HAZARDS IN THE USE OF DENTAL X-RAY APPARATUS. J. Can. Dent. Ass., 33: 371–4 (July 1967).

Rules are proposed for reduction of unnecessary radiation exposure of dental patients and personnel. The x-ray beam should

be collimated, and the diameter should not be more than 2¾ in. at the level of the patient's skin. Aluminum filtration equivalent to 2 mm should be used to reduce the skin dose by absorbing most of the soft radiation. The fastest practicable film should be used to give a radiograph of good interpretative value. The optimum kilovoltage, considering safety and the quality of the radiographic picture, is in the majority opinion in the 60 to 90 KV range. The problem of x-ray leakage may exist with older machines which have inadequate or faulty shielding in the tube housing. The use of a leaded apron on the patient is recommended as a simple means of protecting the gonads from irradiation, and in pregnancy this and the other precautions should be meticulously observed. For protection of the operator, the cord to the timer switch should be long enough to permit him to stand about 10 ft from the patient. The safest position for the operator during the exposure of dental film is at a right angle to the direction of the beam. (BBB)

19335 HEALTH ASPECTS OF SAFETY. Kuhli, Ralph (American Medical Association, Chicago). J. Occup. Med., 9: 163-9(Apr. 1967).

Radiation hazards, accidents, and protective principles are reviewed, in addition to health aspects of safety in other fields. During its 1st 2 decades of existence, the entire atomic energy field has maintained a remarkable safety record. There have been about 10 fatalities to date in radiation accidents in 20 yr. Personal injuries and contamination of the environment from peaceful uses of nuclear power have not occurred. This record represents an excellent example of due regard for the health aspects of safety, demonstrating that with effective safeguards, accidents do not occur. However, because of the expanding nuclear reactor program and because of the great quantities of radioactive waste products produced, the possibility of serious accidents continues to be of concern. This concern increases as use of radioactive materials expands from the major AEC installations, where high standards of radiation safety are maintained, to medical facilities, industrial plants, and research laboratories, where principal disposal routes are the sewer and the incinerator, for liquid wastes and solid wastes, respectively. After 2 decades of success in the safe use of radiation within AEC installations, the new challenge is the establishment and maintenance of equally high standards of radiation safety outside these installations. (BBB)

19336 EFFECTS OF WHOLE-BODY GAMMA IRRADIATION ON SKIN HOMOGRAFTS. Arustamov, D. (Samarkand Medical Inst., USSR). Med. Zh. Uzbek., No. 9, 66-9(Sept. 1966).

Four series of experiments were performed on rabbits and rats to study the effect of γ radiation on tissue transplants. These included studies on controls, with neither animal irradiated (14 rabbits, 12 rats); skin transplanted from nonirradiated donor to irradiated recipient (12 rabbits, 10 rats); skin transplanted from irradiated donor to nonirradiated recipient (12 rabbits, 12 rats); and skin transplanted from irradiated donor to irradiated recipient (14 rabbits, 14 rats). The grafts were rejected in all the animals after the following periods: in series 1, 7 to 13 days in the rabbits, 26 to 33 days in the rats; series 2, 17 to 22 and 32 to 36 days, respectively; series 3, 13 to 16 and 25 to 33 days, respectively; and series 4, 19 to 28 and 33 to 40 days, respectively. The wounds healed after rejection of the grafts much more slowly in the irradiated rabbits and rats than they did in the nonirradiated animals. For example, the wounds took 24 to 32 days to heal in the irradiated rabbits as compared with 18 to 22 days in the controls. (JPRS)

19337 DETERMINATION OF ^{89}Sr AND ^{90}Sr IN FOODS BY ALKALINE EARTH SULFATE SEPARATION. Montag, A. (Chemisches Landesuntersuchungsamt Nordrhein-Westfalen, Muenster, Ger.). Z. Lebensm.-Untersuch. Forsch., 127: 121-30(1965). (In German).

A method is described for separation of ^{89}Sr and ^{90}Sr from ashed food samples that contain large amounts of Ca and P, such as milk. The procedures involve precipitation as the sulfates, followed by extraction of the precipitate with Na ethylenediamine tetraacetate. To avoid the necessity of removing large amounts of protein from the milk, the alkaline earths are removed directly from the milk by precipitation with NH_4 salts and alcohol. Sulfate precipitation separates the alkaline earths quantitatively from Mg, the alkali metals, and from PO_4. However, Sb, Ce, and La may also be precipitated with the alkaline earths. Methods for removal of these contaminants are described. Procedures and equations for measurement of the Sr radioisotopes in the final samples are presented in detail. (BBB)

19338 PROVISIONS ADOPTED BY THE AUSTRIAN GENERAL ACCIDENT INSURANCE INSTITUTE FOR DEALING WITH CONTAMINATED PERSONS. Kucharski, F. Sichere Arb., 19: No. 4, 19-21(Dec. 1966). (In German).

A department in which injured persons with concomitant radioactive contamination are decontaminated before undergoing surgical treatment has been set up in one of the hospitals for accident cases operated by the Austrian General Accident Insurance Institute. The layout and equipment of the department are described. (auth)

19339 ENERGY LOSS OF ALPHA PARTICLES IN TISSUE. Rotondi, E. (National Research Council, Ottawa). Radiat. Res., 33: 1-9(1968).

Stopping powers of alpha particles have been measured for CO_2, O_2, N_2, and CH_4 over an energy range from 0.1 to 5.3 MeV. From these measurements atomic stopping cross sections of alpha particles in tissue (H, 10.1%; C, 12.1%; N, 4.0%; O, 73.6% by weight) were evaluated. For energies less than 1 MeV the results are as much as 50% higher than those calculated by Neufeld and Snyder, assuming that the stopping power of an ion is given by the product of the proton specific stopping power and the average of the square of the charge of the ion. Possible explanations are presented to account for this discrepancy. (auth)

19340 EXTERIOR RADIOCONTAMINATION OF MEAT PRODUCTS. I. STUDY OF THE PROTECTIVE EFFECT OF CASINGS IN THE RADIOACTIVE CONTAMINATION OF SAUSAGES. Raseta, J.; Stankovic, S.; Petrovic, B. (Inst. of Application of Nuclear Energy in Agriculture, Veterinary Medicine, and Forestry, Zemun, Yugoslavia). Acta Vet. (Belgrade), 17: 315-18(1967). (In Yugoslavia).

Cooked sausages were exposed to the action of solutions of $^{90}Sr(NO_3)_2$, $^{137}CsCl$, and $^{144}CeCl_3$ or of an artificial mixture of fission products ($^{90}Sr + ^{140}Ba + ^{137}Cs + ^{144}Ce$ in a ratio of 1 : 1 : 1 : 1). The concentration of the radioisotopes in the solutions was 6×10^{-4} or 0.2×10^{-4} mc/ml. Casings of natural origin (intestine of sheep or cattle) protected the meat of the sausages from penetration of the radioactive isotopes during the first 3 hrs of exposure. After 3 to 6 hrs of exposure, penetration of the isotopes to a depth of 2 mm into the meat took place. On further exposure of the sausages, the depth of penetration increased in an exponential relation to the time of exposure. (JPRS)

19341 DUST DEPOSITION AS AN INDEX OF AIR POLLUTION. Petrovic, Z. (Inst. of Hygiene and Social Medicine, Sarajevo, Yugoslavia). Arh. Hig. Rada Toksikol., 18: 173-8(1967). (In Yugoslavian).

The ratio of radioactive dust deposition to the content of radioactive dust in the air was determined in a number of cities in Yugoslavia during 1961 to 1964. Significant variations in this ratio were found. A statistical evaluation of the results indicated that dust deposition cannot be regarded as an accurate measure of atmospheric dust concentration or as a reliable index of pollution of the atmosphere. (JPRS)

19342 ACTIVITIES IN THE FIELD OF RADIOPROTECTION AT THE CENTER OF ATOMIC AND NUCLEAR PHYSICS AT THE UNIVERSITY OF TOULOUSE. Blanc, Daniel (Faculte des Sciences, Toulouse). Radioprotection, 1: 56-66(1966). (In French).

Teaching and research activities of the center are reviewed briefly. Performance of electronic particle detectors is being studied with emphasis on ionization chambers and Geiger-Mueller counters. Studies are being made on natural radioactive gases present in air. Aerosols and long-lived elements such as Ra and ^{7}Be are being investigated. (H.L.W.)

19343 INTERNAL CONTAMINATION BY ACTIVATED CORROSION PRODUCTS. II. DETERMINATION OF RADIONUCLIDE CORROSION PRODUCTS IN EXCRETION. Fojtik, Marian; Koprda, Vasil, Trnovec, Tomas. Prac. Lek., 20: 2-6(Jan. 1968). (In Czech).

The means of evaluation of internal contamination by radioactive substances are discussed. The excretion functions of some radioisotopes of corrosion products were determined experimentally in rats. The method of determination of the most toxic components of radioisotopes of corrosion products of the nuclear reactor coolant circuit in excreta was worked out. For the biological specimen treatment, nitric acid mineralization, removal of interfering ions by means of sorption on aluminium oxide and removal of inactive salts by means of anion-exchanger is used. The radioisotopes of corrosion products were separated from such treated samples by means of anion-exchange and paper chromatographic methods. (auth)

19344 ASSAY OF ^{90}Sr IN HUMAN BONE IN THE UNITED KINGDOM. Results for 1966, Part II, with some Further Results for 1965. Medical Research Council Monitoring Report No. 15. London, Her Majesty's Stationery Office, 1967. 27p. 3s. 0d. (NP-17275).

Results of assays of ^{90}Sr in samples of human bone from subjects who died in the second half of 1966 are presented in the form of tables. The survey conducted by the United Kingdom Atomic Energy Authority in London contains data based on analysis of vertebrae of subjects of all ages from newborn to adult. Data from the Glasgow survey are based on analyses of femora of newborn and young children. (H.L.W.)

19345 PROBLEMS OF RADIATION PROTECTION IN CONNECTION WITH TRITIUM. Dietrich, E.; Koenig, L. A. (Kernforschungszentrum, Karlsruhe, Ger.). Atompraxis, 13: 454-7 (Oct. 1967). (In German).

A survey is presented on problems connected with the supervision of protection measures for the use of tritium, and solutions are offered. A short report describing tritium supervision at the FR 2 reactor is included. (auth)

19346 STUDIES ON EFFICIENCIES OF CONTAMINATION MEASUREMENT AFTER WIPE-TEST EXPERIMENTS. Sauermann, P. F.; Graf, H. (Kernforschungsanlage, Juelich, Ger.). Atompraxis, 13: 2p.(Oct. 1967). (In German).

Experimental surfaces were contaminated with ^{90}Sr in a water solution of $SrCl_2$. Filter paper, dry or moistened with a mixture of methanol and water, was used to wipe the surfaces. A table shows efficiencies for measurement of contamination after the wipe test for different surfaces such as aluminum, linoleum, and tile, using moist and dry filter paper. There was a wide variation in results for different materials. The efficiency can be assumed to be 0.1 with reasonable accuracy for radiation protection. (H.L.W.)

19347 EXPERIMENTAL CONTAMINATION OF MARGARITANA MARGARITIFERA (MOLLUSCA) WITH ^{137}Cs. Foulquier, Luc; Bovard, Pierre; Grauby, Andre (CEN, Cadarache, France). Compt. Rend., Ser. D, 265: 1745-8(Nov. 27, 1967). (In French).

Experimental contamination of a fresh-water clam with ^{137}Cs made it possible to demonstrate the great capacity of the soft parts for fixation. Contamination of the shell is a result of adsorption phenomena only. At equilibrium the activity of the gills was 430 times that of the water. However, less than 1% of the total activity of the medium was fixed by the living organisms. (tr-auth)

19348 ENVIRONMENTAL SURVEILLANCE OF NUCLEAR FACILITIES. Terrill, J. G. Jr.; Weaver, C. L.; Harward, E. D.; Smith, D. R. Nucl. Safety, 9: 143-9(Mar.-Apr. 1968).

Environmental surveillance programs in the environs of nuclear plants are conducted by local, state, and federal agencies external to the facility's site perimeter or fenced area. Basic to the establishment of these programs is review by the health agency of the plant site, the facility's radioactive-waste discharge system, the specific radionuclides and anticipated normal discharges, and the public-health implications of the presence of these radionuclides. These environmental surveillance programs can be directed at the most sensitive or critical vectors to obtain the data needed to make estimates of population exposure. Preoperational surveys are designed to obtain base-line data, provide training and experience for personnel, and as a mechanism for gathering data for purposes of public information. The basic review and preoperational survey enable the health agency to plan an appropriate surveillance system with respect to required sampling location, frequency, and necessary laboratory analyses. The planning agency directs its sampling under normal and abnormal operations at the possible routes of contaminants or vectors from the source to the population. These include air and water pathways and milk and agriculture food crops. (auth)

19349 RADIATION DOSES FROM ROENTGENDIAGNOSTIC PROCEDURES. Carlsson, Carl (Radiofysiska Institutionen Lasarettet, Lund, Sweden). Handb. Med. Radiol., 3: 640-58(1967).

Extensive data on patient exposures in x ray diagnosis from various countries are compiled, their significance is evaluated, and ways of reducing these doses are reviewed. Genetically significant doses and gonad doses are discussed, and the annual genetically significant doses from x ray examinations in a number of countries are tabulated. Somatic doses for bone marrow, skin, and other tissues are also given. The integral (absorbed) dose is defined and explained. The mean dose, i.e., integral dose divided by body weight, enables direct comparisons of radiation doses from different sources and is probably of greater value than the integral dose in epidemiological investigations of dose-effect relations. Some general rules for reducing the dose include: reduction of the number of x ray examinations; limitation or avoidance of examinations requiring large doses; narrowing the beam so that only the area to be examined is irradiated; use of lead shields; and alteration of technical factors. Use of image intensifiers and television is inferior to roentgenography regarding sharpness of detail and reproduction of weak contrasts, but such equipments can replace ordinary fluoroscopy and the radiation doses can be reduced by more than the power of 10. (BBB)

19350 USE FACTOR IN RADIATION BARRIER DESIGN. Richards, A. G. (Univ. of Michigan, Ann Arbor). Oral Surg., Oral Med., Oral Pathol., 23: 745-50(June 1967).

In the construction of dental offices, protection of persons outside the room from direct and scattered radiation is considered in terms of a use factor, previously generally considered to be $1/4$ for the 4 walls and $1/16$ for the floor and ceiling. To provide a more realistic assessment of the use factors to be used in the planning of primary radiation barriers for dentistry, attempts were made to determine, where and at what frequency the x-ray beam actually exposes the walls, floor, and ceiling during periapical x-ray examinations. By use of photographic methods in conjunction with a scale model of a dental office and a simulated x-ray machine that transmits visible light images of the x-ray beam, it was possible to record the size and location of the floor and wall areas within a dental office that are exposed by the primary beam during such examinations performed with both long- and short-cone techniques. These results indicated the use factor should be $1/16$ for the floor and three exposed walls, and zero for the ceiling and the remaining wall that faces the patient. However, these surfaces are exposed along with the others to secondary radiation and therefore must be considered as secondary radiation barriers. In secondary radiation barrier computations, the use factor for all surfaces in a room is always one, because secondary radiation radiates in all directions and reaches all surfaces. (BBB)

19351 STANDARD RADIOASSAY TECHNICS: A STATUS REPORT. Moeller, Dade W. (Harvard Univ., Boston). Health Lab. Sci., 4: 146-52(July 1967).

Measurements of the concentrations of radioactive materials in the environment, involving the application of a variety of chemical and instrumental methods to many types of media, is reviewed. The professional societies and other organizations associated with the development of the analytical procedures for such measurements are considered under 3 broad categories: international, governmental, and professional societies. A list of radiological methods developed or under consideration by various societies is given. More than a dozen international organizations, federal agencies, and professional societies are actively participating in programs related to the development of standard radioassay techniques. An evaluation of the present situation is given, and some of the problems faced in the development of standard radioassay techniques are discussed. One is the need for methods which are accurate and yet sensitive enough to determine near zero concentrations of radiocontaminants in an ever-increasing variety of media. Another problem results from the continual advancement of electronic radiation detection instrumentation, leading to publication of methods which are already out of date. Still another problem is the lack, in many cases, of sufficient collaborative studies either to confirm the soundness of a method or to correct its deficiencies. Too often, techniques have been published which contained errors or lacked sufficient detail for routine use. (BBB)

19352 DOSE RATE FROM HIGH-ENERGY ELECTRONS AND PHOTONS. Alsmiller, R. G. Jr.; Moran, H. S. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods, 58: 343-4(Jan. 1968).

Electron-photon cascade calculations were carried out, and energy deposition as a function of depth was obtained for monoenergetic electrons (0.1 to 20 GeV) and photons (0.01 to 20 GeV) normally incident on a semi-infinite slab of water 30-cm thick. The calculated results are in approximate agreement with experimental data for the case of 5.2-GeV incident electrons. (auth)

19353 GEL SCINTILLATION COUNTING OF ^{131}I IN PLASMA AT HIGH EFFICIENCIES. Bell, T. K. (Royal Victoria Hospital, Belfast). J. Clin. Pathol., 20: 629-30(July 1967).

A method is described for assaying low concentrations of ^{131}I in plasma by detecting the β radiation in a gel scintillator. Higher detection efficiencies were obtained compared with measurements of the γ radiation from this radioisotope using a well-type crystal of NaI. Determination of the concentration of protein-bound ^{131}I in plasma in association with ^{131}I net uptakes provided a useful method for investigating patients with abnormal thyroid function. Forty-eight hours after an oral dose of 20 to 50 μCi ^{131}I, 10 to 12 ml blood was removed from the patient, centrifuged, and the plasma passed through an anion exchange resin to remove any residual inorganic radioiodine. The small amount of protein-bound ^{131}I ($PB^{131}I$) present in the eluate was determined using the simple

liquid scintillation counting method described. A liquid scintillator solution was prepared by dissolving 7 g of 2,5-diphenyloxazole (PPO), 0.3 g of 1,4-bis-2(4-methyl-5-phenyloxazolyl)-benzene (dimethyl POPOP), and 100 g of naphthalene in dioxane to a final volume of 1:1, and to this solution 50 g Cab-o-Sil was added to yield a gel scintillator. Counting efficiencies ranged from 85.3 to 49.5% for volumes 1.0 to 3.8 ml. The efficiency for detecting ^{131}I in the well-type scintillation counter ranged from 26 to 21.1% for plasma volumes of 1.0 to 5.0 ml. (BBB)

Medicine

Refer also to abstracts 18710, 19097, 19251, 19292, 19320, 19349, 19350, 19402, 19419, 19437, 19440, 19450, 19452, 19453, and 19458.

19354 (BNL-11999) LATE EFFECTS OF RADIOACTIVE FALLOUT ON THE THYROID GLAND IN A MARSHALLESE POPULATION. Conard, R. A. (Brookhaven National Lab., Upton, N. Y.). Dec. 4, 1967. 10p. (CONF-671208-1). Dep. CFSTI.

From 134th Annual Meeting of the American Association for the Advancement of Science, New York.

A review of the early, acute effects of fallout from the thermonuclear explosion of 1954 is presented. The iodine isotopes, ^{131}I, ^{132}I, ^{133}I, and ^{135}I were absorbed by the thyroid from contaminated food and water. It was estimated that children under four years of age received doses between 700 and 1400 rads from the iodine isotopes. Until recently annual examinations did not reveal any apparent abnormalities of the thyroid. However, within the last two or three years 19 people with thyroid abnormalities were noted, nearly all of these occurring in the more heavily exposed group. Sixteen of these occurred in children less than ten years of age. The high incidence in children was related to the larger dose. A table is presented to show incidence of thyroid nodules as related to radiation dose to thyroid from iodine isotopes, external gamma radiation dose, and age at exposure. Thyroid surgery was performed on nine children and two adults. It was found that all of the nodules in children were benign. Atrophy of the thyroid glan and hypothyroidism were present in two boys; these two were th most retarded in growth and development. Thyroid hormone therapy was initiated on the exposed people; results indicate a reduction in thyroid nodules and improved growth in children. (H.L.W.)

19355 (JAERI-1150) HEALTH ADMINISTRATION AT JAPAN ATOMIC ENERGY RESEARCH INSTITUTE (MAINLY BY BLOOD EXAMINATION). Ohira, Ichiro; Hori, Goziro; Kobayashi, Hiroo (Japan Atomic Energy Research Inst., Tokyo). Aug. 1967. 7p. (In Japanese). Dep.

At the Tokai Research Establishment of the Japan Atomic Energy Research Institute work is carried out in dermatology, ophthalmology, examinations of blood and urine, as well as general examinations. Results of these examinations from 1961 to 1966 were analyzed, with emphasis on blood examinations associated with radiation injuries. A tendency toward an annual decrease in the leukocyte count was observed in the JAERI personnel. This phenomenon was presumed to be prevalent throughout the country. The importance of urinary examinations for early diagnosis of diabetes and other diseases is emphasized. (H.L.W.)

19356 COMPUTER PROGRAM FOR TRACING RADIOACTIVITY IN COMPLEX METABOLIC SYSTEMS. Haut, Michael; Basickes, Sandra (Univ. of Pennsylvania, Philadelphia). Comput. Biomed. Res., 1: 139-45(July 1967).

In computer simulation studies or other detailed studies of radioisotope distribution in metabolic pathways, when an isotope-labeled substrate is added, it is necessary to know what new labeled compounds are produced and how these new compounds originate. Determination of the complete isotope distribution pattern is time-consuming and often inaccurate. Since such studies often involve adding the same substrate several times, with different labeling, a computer program for determining labeling patterns was prepared, written in assembly language for the Control Data 160-A computer. Input for this program consists of a set of equations describing the unlabeled system, and a specifically labeled compounds. Computation consists of a series of passes, in which all the input equations are executed in order, using all possible labeling combinations of the reacting substances. The output consists of all the new equations, i.e., equations containing new labeled compounds, or new types of equations forming labeled compounds already present resulting from each pass. Application of this program to the study of highly interconnected metabolic system is discussed, particularly the pentose shunt, glycolysis (which shares several intermediates with the shunt), and the tricarboxylic acid cycle. For this, 58 equation cards were used to represent reactions involving 19 (unlabeled) compounds. When 1-^{14}C-labeled glucose-6-phosphate was added to an unlabeled system, 175 equations were generated after 2 passes; when important equations were selected from the third pass, the number was brought up to 246. When 6-^{14}C-labeled glucose-6-phosphate was added, 148 equations were generated after 3 passes; a total of 256 were generated by the end of the fourth pass. When a compound with 2 carbons labeled, 3,4-^{14}C-glucose-6-phosphate, was added, nearly 1000 equations were generated after 2 passes. Usually no more than 3 passes were needed to generate all the important labeled forms. (BBB)

19357 EFFECTS OF A COMBINATION OF RADIOPROTECTIVE SUBSTANCES ON MIGRATION OF CRYPT CELLS ALONG THE VILLI OF THE MOUSE DUODENUM. Maisin, J. R.; Lambiet-Collier, M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Compt. Rend. Soc. Biol., 161: 1134-8(1967). (In French).

Effects of a combination of AET, glutathione, and 5-hydroxytryptamine on the mitotic cycle of the epithelial cells of the small intestine and on the migration velocity of crypt cells along the villi were studied. The results showed that the radioprotective substances given in association decreased the metabolic activity of the epithelial cells of the intestinal crypts as demonstrated by reduction of the incorporation of tritium-labeled thymidine in the DNA and lengthening the mitotic cycle. The lengthening occurred essentially in the G2 phase and in the phase of DNA synthesis. The metabolic decrease in the epithelial cells of the small intestine resulted in a reduced velocity of the migration of the crypt cells along the villi. (H.L.W.)

19358 INFLUENCE OF SOME DRUGS ON EMPTYING OF THE STOMACH OF IRRADIATED MICE. Grossmann, V.; Horackova, O.; Kopalova, A. (Charles Univ., Hradec Kralove, Czech.). Cesk. Fysiol., 16: 145(Mar. 1967). (In Czech).

Experiments with mice irradiated with 600 R indicated that parasympathomimetic drugs have a tendency to normalize stomach motility after irradiation. (JPRS)

19359 ROLE OF RECOVERY IN MODIFICATION OF YEAST SURVIVAL CURVES DURING CELL GROWTH IN MEDIA WITH DIFFERENT NUTRIENT CONTENTS. Kapul'tsevich, Yu. G.; Bliznik, K. M. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya, 7: 572-5(1967). (In Russian).

Diploid Saccharomyces vini, strain Megri 139-V, were cultivated on wort-agar solution for three days at 30°, washed, centrifuged, and filtered, and then put in suspension at 10^8 cells per liter. The suspension was irradiated at 72 R/sec. Survivors were counted after 5 and 8 days of incubation at 30°. It was found that the modification of survival observed in irradiated yeast in nutrient media occurs because cells grown on different media show different recoveries. Damage in a medium without nutrient is irreversible. (JPRS)

19360 A PILOT STUDY OF METHOTREXATE, DUAZOMYCIN A, AND RADIATION THERAPY IN CARCINOMA OF THE LUNG. Foley, H. Thomas (National Cancer Inst., Bethesda, Md.); Shnider, Bruce I.; Gold, G. Lennard; Rius, Jorge. J. New Drugs, 6: 105-11(Mar.-Apr. 1966).

The possible synergistic effects of ionizing radiation and chemotherapy on lung cancer was investigated in 23 patients. Patients were allocated randomly to one of three treatment regimens: radiation alone, radiation plus Duazomycin A, or radiation plus Methotrexate. Orthovoltage (250-KV) x radiation therapy was given through single or opposing multiple fields, 200 RAD per day, five days per week. The anticipated tumor dose was to be 6000 RAD or until cutaneous reaction prohibited further treatment. Both drugs were started four days prior to the beginning of radiotherapy. Thereafter, Duazomycin A was given only on days that radiation therapy was given. The dose of both drugs was reduced when bone marrow suppression occurred, or stopped altogether in the presence of stomatitis, diarrhea, or azotemia. Radiotherapy was halted only when a localized radiodermatitis developed. Of the nine patients treated with radiation only, mild radiodermatitis was seen in four. None showed evidence of marrow suppression. In two there were favorable responses: one of 50% tumor regression and one of 90%. With radiotherapy plus Duazomycin A, there were no favorable responses in spite of the fact that all seven patients received adequate radiotherapy and that four showed mild bone marrow suppression. In the radiotherapy plus Methotrexate group, therapy was stopped after 1600 R in one of the seven patients because fatal leukopenia developed. Five of the other six also developed leukopenia, and radiodermatitis occurred three times and was severe in one instance. Severe stomatitis occurred twice. There were three favorable responses, one of which was complete.

The mean survival times were 4.6, 6.3, and 6.0 in the respective groups. It was concluded that there was no clear-cut potentiation demonstrated, the groups being too small to show a significant difference. (BBB)

19361 PHOTOALLERGIC CONTACT DERMATITIS DUE TO HALOGENATED SALICYLANILIDES AND RELATED COMPOUNDS. Harber, Leonard C.; Harris, Harriet; Baer, Rudolf L. (New York Univ., N. Y.). Arch. Dermatol., 94: 255-62(Sept. 1966).

Effects of uv light on the skin of patients with drug photosensitivities are reported. It was demonstrated that uv radiation in the wavelength range of 3200 to 4500 Å was required for initiation of these photoallergic reactions. Histologically, photoallergic contact dermatitis was identical with allergic contact dermatitis, but it was distinctly different from phototoxic contact dermatitis. The five patients studied had photoallergic contact dermatitis due to halogenated salicylanilides and chemically related antimicrobial agents. Cross-photosensitivity was demonstrated between tetrachlorosalicylanilide, tribromosalicylanilide, and bithionol, but not with hexachlorophene. Allergic contact sensitivity to some of these compounds may be present simultaneously with or without photoallergic contact sensitivity. It was proposed that the mechanism mediating photoallergic contact sensitivity to halogenated salicylanilides was that uv light (3600 Å) caused the formation of a free radical derivative that bound with cutaneous proteins. This new hapten-protein unit then acted as a photoantigen. (BBB)

19362 TUMOR LOCALIZING AGENTS. I. SYNTHESIS AND TISSUE DISTRIBUTION OF ^{14}C-LABELED AND RADIOIODINATED 5,6-DIACETOXYINDOLE. Counsell, R. E.; Smith, T. D.; Doelle, J.; Meier, D.; Beierwaltes, W. H. (Univ. of Michigan, Ann Arbor). J. Pharm. Sci., 56: 1019-22(Aug. 1967).

Some radiolabeled precursors of melanin were synthesized, in an attempt to develop new diagnostic and therapeutic methods for malignant melanoma. Compounds were sought that would selectively concentrate in melanotic tissues. Since a high target–nontarget ratio in melanomas compared to surrounding tissues was desired, precursors formed in the later stages of melanogenesis were investigated. The synthesis and preliminary tissue distribution data for two radiolabeled derivatives of 5,6-dihydroxyindole are reported. Since 5,6-dihydroxyindole is a late precursor of melanin, the synthesis of this material labeled with ^{14}C was undertaken. However, it proved to be too unstable and was therefore converted to the diacetate for animal studies. The radioiodine-labeled analog was prepared by iodine exchange of 5,6-diacetoxy-7-iodoindole with sodium iodide ^{125}I. Neither 5,6-diacetoxyindole-2-^{14}C nor the ^{125}I analog showed a predilection for melanomas in mice. (BBB)

19363 LATE EFFECTS OF RADIOACTIVE IODINE IN FALLOUT: COMBINED CLINICAL STAFF CONFERENCE AT THE NATIONAL INSTITUTES OF HEALTH. Robbins, Jacob (National Inst. of Arthritis and Metabolic Diseases, Bethesda, Md.); Rall, Joseph E.; Conard, Robert A. Ann. Intern. Med., 66: 1214-42(June 1967).

Late effects of irradiation of Marshall Islanders exposed to fallout in 1954 are discussed, with emphasis on thyroid disorders and associated growth retardation in some exposed children. Thyroid irradiation from radio-iodine, particularly in the children, was appreciable. This resulted in the late development of thyroid insufficiency or thyroid nodules or both in 80% of those children exposed at less than 10 yr of age. At present, thyroid effects constitute the only important overt medical problem in the exposed population. Detection of thyroid damage was hindered by its insidious onset and by the unexpected endemically elevated blood levels of iodoprotein in the Marshallese population. The greater prevalence of thyroid abnormality in the children is probably a result of two factors: a larger radiation dose due to small thyroid glands and a greater likelihood of the growing organ to manifest changes resulting from chromosomal alterations. Mechanisms of induction of radiation injury to the thyroid and its sequelae are discussed. Retarded growth in several exposed children is attributed to hypothyroidism, and is being treated by thyrotropin administration. (BBB)

19364 INFLUENCE OF PROCAINE ON BLOOD PRESSURE OF IRRADIATED RATS. Martinkova, J. (Charles Univ., Hradec Kralove, Czech). Cesk. Fysiol., 16: 146-7(Mar. 1967). (In Czech).

Procaine caused a higher degree of hypotension in irradiated than in control rats when administered via the vena saphena and the vena jugularis. (JPRS)

19365 RADIO RESISTENCE OF TISSUES IN VARIOUS STRAINS OF MICE AND EFFECTS OF PROTECTIVE SUBSTANCE. Domareva, O. P. Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 200-5(1965). (In Russian).

Mitotic activity of corneal epithelium in mice of various strains (C_3H, $CC_{57}Br$ and BALB/c), irradiated with x rays (600 R) after administration of diethylstilbestrol, was studied. It was shown that x rays reduced the mitotic activity. This reduction reached a maximum in mice of the BALB/c strain and a minimum in $CC_{57}Br$ mice. The recovery proceeded faster in $CC_{57}Br$ mice and slower in BALB/c mice. The protective action of diethylstilbestrol occurred to a greater extent in the less radioresistant strain, BALB/c as compared with the more radioresistant strains, $CC_{57}Br$ and C_3H. (auth)

19366 SENSITIZATION OF SHIGELLA FLEXNERI Y6R AND ESCHERICHIA COLI B/r TO IONIZING RADIATION BY PRETREATMENT WITH CUPROUS (Cu I) COMPOUNDS. Cramp, W. A. (Hammersmith Hospital, London). Radiat. Res., 33: 10-21(1968).

Pretreatment of two strains of bacteria, Shigella flexneri and Escherichia coli B/r, with toxic concentrations of cuprous (Cu I) or cupric (Cu II) solutions resulted in an enhancement of radiosensitivity of the surviving bacteria. Irradiation of the sensitized bacteria in the presence of thiourea (0.3 M) or glycerol (1 M) gave survivals that would be expected with nonsensitized protected bacteria. These results suggested that the modification of the cell by copper treatment increased the sensitivity by producing molecular arrangements that have the same characteristics of energy dissipation as those responsible for radiation sensitivity in the untreated cells. The same strains of bacteria when sensitized to ionizing irradiation by copper pretreatment were not more sensitive to uv light at 2537 Å. However, when survivors from an uv dose sufficient to kill 90% of the population were exposed to toxic solutions of cuprous compounds, they were considerably more sensitive than unirradiated bacteria. This result stands in contrast to that previously reported, where the effect of ionizing radiation was to decrease the sensitivity of the survivors to solutions of cuprous compounds. (auth)

19367 SURVIVAL OF WHOLE-BODY-IRRADIATED HIBERNATING AND ACTIVE GROUND SQUIRRELS; CITELLUS TRIDECEMLINEATUS. Musacchia, X. J.; Barr, R. E. (Univ. of Missouri, Columbia). Radiat. Res., 33: 348-56(1968).

Active and hibernating ground squirrels, Citellus tridecemlineatus, were exposed to whole-body ^{60}Co gamma rays at dose rates of 190 to 175 rads per minute over a range of doses of 900 to 20,000 rads. The results showed that over the entire range of exposures those animals that were irradiated while hibernating (body temperatures circa 5°C) and then immediately aroused from torpor were more radioresistant than the similarly irradiated active animals (body temperatures circa 37°C). This conclusion applied to both mean survival times and percentage of survival. Summer animals, as compared with winter animals, both active and hibernating, were found to be less resistant. The fact that these experiments involved levels of radiation that spanned the three radiation syndromes (hematopoietic, gastrointestinal, and central nervous system) suggest that the protective effects afforded by hibernation are broadly operative. (auth)

19368 MULTIPLICITY REACTIVATION OF GAMMA- AND X-IRRADIATED VACCINIA VIRUS IN L CELLS. Kim, K. S.; Sharp, D. G. (Univ. of North Carolina, Chapel Hill). Radiat. Res., 33: 30-6(1968).

The degree of aggregation among the particles in preparations of vaccinia virus was evaluated by electron microscopy and found to be closely correlated with surviving plaque titer after irradiation with either soft x rays or gamma rays from ^{137}Cs. Low plaque titer of dispersed virus preparations is increased by aggregating the particles after irradiation, showing that the high survival in aggregated preparations is not the result of protection. This evidence of multiplicity reactivation (MR) is displayed equally by virus irradiated with soft x rays or with gamma rays, and it is similar in magnitude to that shown with ultraviolet rays. In this respect the response of vaccinia virus differs sharply from that previously shown for the coliphages that exhibit no MR if exposed to soft x rays prior to adsorption by host cells. (auth)

19369 RADIATION DISTURBANCES OF THE GENETIC INFORMATION IN A CELL. Shal'nov, M. I.; Savich, A. V. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 698-7(1967). (In Russian).

Result of work radiation injury to genetic information materials are summarized, (1958–1967, 85 references). Damage of nitrogenous bases of nucleic acids that change the meaning of genetic information were studied on simple models with two types of radiolytic reactions, those accompanied by change in the ring structures (losses) and those taking place in the added group (modifica-

tions). The type of individual radiosensitivity of bases in quantum chemistry is explained by energy and structural characteristics of the molecular orbits which determine the ability of the bases to add free radicals. Schemes of the substitution of amino acids in polypeptides synthesized under the control of mutated genes are presented, as well as experimental models for study of radiation disorders of genetic information. The prevention of genetic damages was studied by the prophylactic treatment of microbial cells with iodoacetamide before irradiation, which sensitizes them toward irradiation, and the prophylactic administration of amino acids to mice intravenously in doses of 2–8 mg/g 1 to 4 minutes before irradiation with a dose of 700 rad, as well as the elimination of genetic damages that arose by means of nucleic preparations. (JPRS)

19370 MEASUREMENTS OF BIOLOGICAL EFFECTS AND PHYSICAL PARAMETERS OF NEUTRONS FROM THE $^{9}Be(^{3}He,n)^{11}C$ REACTION; POSSIBILITIES FOR FAST NEUTRON RADIOTHERAPY. Broerse, J. J.; Barendsen, G. W. (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Rijswijk). Int. J. Radiat. Biol., 13: 189-94(1967).

The clone technique was used to study quantitatively the effect of cyclotron-produced neutrons on the reproductive capacity of mammalian cells cultured in the presence or absence of oxygen. Results showed that neutrons produced by the $^{9}Be(^{3}He,n)^{11}C$ reaction do not differ significantly from values which were found previously for other fast neutron beams. With regard to the oxygen effect, the cyclotron-produced neutrons are not preferable to neutrons of other energies. At a distance of 18 cm from the target the dose-rate amounted to 28 rads/min for an ion current of 20 μA. To obtain sufficient collimation of the cyclotron-produced fast neutron beam the objects to be irradiated must be positioned at a distance of at least 60 cm from the target. For this position a dose-rate of 13 rads/min can be calculated for an ion current of 100 μA, which is the maximum presently attainable for compact cyclotrons. This dose-rate obtained for neutrons produced by the $^{9}Be(^{3}He,n)^{11}C$ reaction is comparable to the dose-rate obtainable with a 15 MeV neutron beam produced by the $T(d,n)^{4}He$ reaction for a yield of 10^{12} n/sec. As far as the depth-dose characteristics are concerned, the cyclotron-produced fast neutrons have less favorable characteristics for radiotherapy than 15 MeV mono-energetic neutrons. The measurements for various field sizes showed that the depth-dose curves are similar to those of 300 kVp x rays. Although neutrons with energies up to 33 MeV are produced in the $^{9}Be(^{3}He,n)^{11}C$ reaction, the large contribution of neutrons with energies below 10 MeV is presumably responsible for the poor depth-dose parameters. This penetration is probably not sufficient for the effective treatment of deep-seated tumors. The depth-dose characteristics of 15 MeV neutrons are shown to be comparable to those of ^{137}Cs γ rays. It was concluded that for fast-neutron radiotherapy, neutrons from the $T(d,n)^{4}He$ reaction are preferable to neutrons from the $^{9}Be(^{3}He,n)^{11}C$ reaction. (C.H.)

19371 GAMMA CAMERAS FOR CLINICAL DIAGNOSTICS. Lorenz, W. J. (Institut fuer Nuklearmedizin, Heidelberg). Kerntechnik, 9: 542-5(1967). (In German).

Gamma cameras are stationary detector systems that have become very important during these last few years for the diagnosis with incorporated radionuclides (scintigraphy). These cameras are suitable for topographical studies and especially for scintigraphical function measurements. Quantitative information on the function of organs can be obtained by evaluation of the camera scintigrams with digital computers. The design and performance of the Anger camera, the positron camera, the digital autofluoroscope, the image intensifier camera, and the spark camera are being discussed, as well as their characteristics and developmental possibilities. (auth)

19372 ROLE OF SULFHYDRYL GROUPS IN DETERMINING NATURAL RADIOSENSITIVITY AND ITS ARTIFICIAL VARIATIONS. Graevskii, E. Ya. (Inst. of Biology of Plants, Moscow). Radiobiologiya, 7: 715-27(1967). (In Russian).

The article presents a survey of the literature (161 references, 1939–1957) on reasons for contradictory differences in radiosensitivity. Knowledge of the factors on which differences observed in nature depend can be very important in seeking methods of artificially changing radiosensitivity. Radiosensitivity can be said to increase with complication of structure, but in its main features can be considered a cellular problem, with DNA likely being the principal target. Data indicate that the sulfhydryl groups can be a common basis of natural and artificial radiosensitivity, their level in the cell can determine radiosensitivity. The role of the sulfhydryl groups also has not been proven, and it has been suggested that their effect is not attributable to their participation in the act of protection, but rather to changes they cause in the biological object such as possible increased activity of enzymes that shift the thiol-disulfide equilibrium in the direction of increase of SH-groups in the cell. Various radioprotectors increase content of SH-groups. There is more and more evidence that the SH-groups have a determining importance in natural and artificial variable radiosensitivity, not as the substrate responsible for owing to the role of natural radioprotector which is inactivated as a result of interactions with other intracellular substances damaged by radiation. (JPRS)

19373 CHEMICAL PROTECTION AGAINST THE EARLY EFFECTS OF X RAYS ON THE INCORPORATION OF TRITIUM LABELED THYMIDINE IN THE EMBRYONIC CHICK INTESTINE IN VITRO. Kirrmann, Jean-Michel (CNRS, Nogent-sur-Marne, France). Compt. Rend., Ser. D, 265: 1419-21(Nov. 6, 1967). (In French).

The intestine was removed from a 12-day chick embryo, cut into four pieces, and cultivated in vitro. The first piece was used as a control; the second was x-irradiated (800 to 3750 R) immediately after explantation; the third was treated with cysteamine; and the fourth was treated with cysteamine and x-irradiated. After treatment, all pieces were placed in a medium containing tritium-labeled thymidine for four hours. Histological sections were prepared, and the numbers of labeled nuclei in relation to the total number of nuclei in the mesenchyme and epithelium were counted. It was found that the inhibiting effect of x rays on the incorporation of tritium-labeled thymidine was considerably reduced by cysteamine. (H.L.W.)

19374 EFFECTS OF CHEMICAL PROTECTIVE SUBSTANCES ON THE SURVIVAL AND MUTATIONS IN VARIOUS ORGANS IN MICE WITH DIFFERENT SENSITIVITY TO X IRRADIATION. (EFFECTS OF CARBON MONOXIDE). Nuzhdin, N. I.; Nechaev, I. A. Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 206-22(1965). (In Russian).

Differences have been established between effects of carbon monoxide on mice of the radioresistant ($CC_{57}Br$) and radiosensitive (C_3H) strains irradiated with a total dose of 600 R. Differences in radiation effects with respect to differences in certain interior indices of these strains of mice under normal conditions were discussed. (auth)

19375 INITIAL STUDIES INTO CYTOMORPHOLOGICAL CHANGES IN THE IRRADIATION TREATMENT OF CERVICAL CANCER. Yang, Ta-wang; Huang, Fu-hsiang; Wan, Li-chen (Jeh-t'an Hospital, Chinese Academy of Medical Sciences, China). Chung Hua Fu Ch'an K'o Tsa Chih, 11: 107-110(Mar. 1965). (In Chinese).

Cytological slides were used as a means of observing the effects of irradiation in the treatment of cancer. The method used is described. Twelve cases were studied and analyzed according to clinical conditions and course of irradiation. Results showed that the use of cytological slides was more favorable than the use of tissue slides. Results agreed with Graham's contention that cellular enlargement coincides with the rise and fall of the curve for morphological changes. It was concluded that using the number of largest cells was a simple and efficient way of determining irradiation reaction. Since there was little relationship between cytomorphological change, numbers of enlarged cells, cancer cell change and disappearance, clinical stage of cervical cancer, pathological mode and degree of differentiation, the least that could be said for these factors in estimation of prognosis was that when the reaction to irradiation was good then results would be good. (JPRS)

19376 PROTECTION OF SPERMATOZOA OF RABBITS AGAINST GENETIC DAMAGE CAUSED BY IRRADIATION IN VITRO. Nuzhdin, N. I.; Nizhnik, G. V. Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 229-37(1965). (In Russian).

A number of substances were studied for their protective action against genetic damage caused by the Co^{60} radiation (800 R) of rabbit spermatozoa in vitro. The protective substances (cysteamine, AET, cysteine and carbon monoxide) administered into the ejaculate prior to exposure did not reduce the rate of incidence of dominant lethals. With spermatozoa irradiated in an atmosphere of nitrogen, the percentage of normally developing embryos in females inseminated with such spermatozoa was four times as high as that in females inseminated with spermatozoa irradiated in the air. The use of S^{35}-labeled β-mercaptoethylamine showed that the protective substance penetrated into the spermatozoa where it was accumulated in sufficiently high concentrations. (auth)

19377 EFFECT OF ESTROGENS ON THE METABOLISM OF ADRENALS UNDER NORMAL CONDITIONS AND AFTER IONIZING RADIATION. Graevskaya, B. M.; Shchedrina, R. N.

Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 223-8(1965). (In Russian).

Mice of the BALB/c strain were used to study the ability of diethylstilbestrol to normalize changes in the catecholamines level of the adrenal glands as caused by x radiation with a dose of 600 R. The administration of diethylstilbestrol (0.2 mg in 0.2 ml of olive oil) led to a pronounced and lasting reduction in the content of catecholamines. At the same time, diethylstilbestrol administered 10 days prior to irradiation procluded the rise in the catecholamines level in the adrenal glands, observed four to seven days following the exposure. (auth)

19378 EFFECT OF LEOPHACE ON THE FUNCTION OF MITOCHONDRIA OF THE LIVER OF IRRADIATED RATS. Supron, L. F.; Gul'ko, V. V.; Zhigalkovich, A. S.; Kamentseva, V. I.; Korobenkova, M. M.; Lastovskaya, T. G.; Pushkarev, V. F.; Razumovich, A. N. Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk, No. 3, 125-7(1967). (In Russian).

The effects of small doses of leophace (acetone solution of yperite) on the biological oxidation system and oxidative phosphorylation in liver mitochondria of x-irradiated white rats were studied. Leophace was introduced internally in doses of 1 μg/kG animal weight. The results showed that leophace activates the phosphorylating activity and the oxidation of the liver mitochondria of irradiated animals. This stimulation is absent if the irradiated animals are subjected to physical stress. Leophace clearly stimulates the activity of pyruvatedehydrogenase and the activity of α-ketoglutarate dehydrogenase. The cytochrome oxidase activity stayed at a normal level in all cases. Leophace also decreases the level of glycogen in the liver. The protective effect of small doses of leophace during radiation of the organism is connected with the mobilization of the energy resources of the cell. (tr-auth)

19379 THE EFFECT OF ECOLOGICAL CULTIVATION CONDITIONS AND THE PHYSIOLOGICAL CONDITION OF SEEDS (DEGREE OF MATURITY) ON RADIOSENSITIVITY AND THE FREQUENCY AND CHARACTER OF HEREDITARY CHANGES IN GAMMA-IRRADIATED BARLEY. Nuzhdin, N. I.; Pastushenko-Strelets, N. A.; Shangin-Berezovskii, G. N. (Inst. of Genetics, Moscow). Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 18-68 (1965). (In Russian).

Experiments were conducted to determine the effect of different ecological conditions on the sensitivity to irradiation of gamma-irradiated barley seeds. The dose of gamma rays varied but did not exceed 12 krad. Experimental and control seeds were sown in Moscow, Estonia, Khibiny, Odessa, Kharkov, Leninavan, Kedabek, Kelbedzhar, and Pamir. Results showed a definite relationship between the radiosensitivity of plants grown from irradiated seeds and their ecological cultivation conditions. Futhermore, the cultivation conditions for plants of the generation preceding irradiation significantly influenced the radiosensitivity of seeds collected from them and sown under identical conditions. It was known that seeds of the same variety, irradiated at a different degree of maturity, had different radiosensitivity. It had also been established that different ecological conditions influence the variability of quantitative plant characteristics (such as height of the culm and length of the spike) differently in the first generation of barley grown from irradiated seeds. Important differences in these indices were also observed between control plants of the same variety grown under different conditions. Experiments showed that the influence of conditions of cultivation prior to irradiation on the variability of these quantitative indices was manifested fairly clearly and was retained in the second generation. Another part of this series of experiments showed that the number and character of structural changes in barley during irradiation frequently depended on the ecological conditions in which the plants grew prior to and after irradiation. The variability of quantitative and morphological features observed in the first generation of plants was a function of the different maturation phase of the seeds from which they grew. Structural changes in the barley spike were the result of irradiation. It was shown that cultivation conditions of the mother plants prior to gamma irradiation had an essential influence on the frequency of appearance and character of lethal chlorophyll mutations in the second generation. The frequency of appearance of chlorophyll mutations in the second generation of gamma-irradiated barley depended on the maturation phase of irradiated seeds. Viable mutations during gamma irradiation of barley were few, and thus no rule for their occurrence could be established. However, it must be noted that visible mutations occurred most frequently when plants were cultivated prior to irradiation or afterwards under unnatural conditions. (JS)

19380 ANTIRADICAL PROPERTIES OF ANTIBIOTICS IN DIFFERENT SYSTEMS. Burlakova, E. V.; Kozlov, Yu. P.; Tambiev, A. Kh.; Taranenko, G. A.; Tkhor, L. F. Tr. Mosk. Obshchest. Ispyt. Prirody, Otd. Biol., 16: 193-7(1966).

The antibiotics gramicidin, fumagillin, aurantin, streptomycin, biomycin, penicillin, and hydroxytetracycline are known to have a protective effect against radiation injury in higher and lower organisms. An investigation of their antiradical activity in various systems showed a pronounced protective effect on the backgound of the radiomimetic action of oxidized oleic acid in mice and yeasts. Electron paramagnetic resonance studies of these antibiotics and their derivatives revealed that a free radicle state for these substances was possible, decreasing the yield of free radicals of 1,1-diphenyl-2-picrylhydrazyl in an EtOH solution. A reaction is indicated between the oxidation products of oleic acid and the antibiotic molecules in free radical states. The antibiotics may also act as traps for free oxidized oleic acid radicals. (auth)

19381 RADIOISOTOPIC METHODS IN THE DIAGNOSIS OF RENAL VASCULAR DISEASE: A CRITICAL REVIEW. McAfee, John G. (Upstate Medical Center, Syracuse, N. Y.); Reba, Richard C.; Chodos, Robert B. Seminars Roentgenol., 2: 198-220(Apr., 1967).

A review (with 48 references) is presented on renal diagnostic techniques utilizing ^{131}I-hippuran and ^{197}Hg- or ^{203}Hg-labeled chlormerodrin, including an assessment of the radiation doses. The radiation dose levels from ^{131}I-hippuran renography are small. One report gave a figure of 2 mrad total-body dose per 10 μCi ^{131}I-o-iodophippurate administered. From tissue concentrations obtained in rats, an intravenous injection of 30 μCi ^{131}I-hippuran was calculated to deliver a renal dose of only 19 mrad, of which 15 mrad was attributable to the slowest component with an effective half-time of ~12 hr. The tissue receiving the largest radiation dose is the mucosa of the bladder (~10 mrad), but the dose is markedly dependent on urinary output and bladder emptying times. The total-body dose from 30 μCi was calculated to be 0.3 mrad and the hepatic dose 0.8 mrad. In comparison with ^{131}I-hippuran, the radiation dose from radiomercury-labeled chlormerodrin is much larger, particularly when 150-μCi amounts are used for renal scanning. The critical tissue is the cortex of the kidney except in renal insufficiency, when the hepatic dose may be even higher. The renal dose delivered by 150 μCi ^{203}Hg-chlormerodrin varies from 8 to 33 rad. The total-body radiation dose is only 0.13 rad. By using ^{197}Hg (physical half-time 2.7 days) instead of ^{203}Hg (half-life 45 days) the renal radiation dose is reduced to about 1.6 rad and the total-body dose 0.012 rad. (BBB)

19382 THE MEASUREMENT OF OXYGEN TENSION IN TUMOURS AND THE EFFECT OF BREATHING OXYGEN BEFORE AND AFTER RADIOTHERAPY. Cater, D. B.; Silver, I. A. (Cambridge Univ., Eng.). pp 358-68 of The Treatment of Cancer, With Special Reference to Radiotherapy and Chemotherapy. Mitchell, J. S. (ed.). Cambridge, Eng., University Press, 1965.

Radiobiology of the oxygen effect is considered, in particular the effect of oxygen inhaled at atmospheric pressure as a radiosensitizer in radiotherapy, alone or in combination with intravenous injections of Synkavit (tetrasodium 2-methyl-1,4-naphthaquinol diphosphate). The effect of irradiation on the oxygen tension of normal and tumor tissues was followed by a polarographic method in cancer patients. The resting level of oxygen tension, and response to oxygen breathing at atmospheric pressure, in tumor and adjacent normal tissue was measured before and after radiotherapy. The ratio (tissue P_{O_2} when breathing oxygen/tissue P_{O_2} when breathing air) was a constant of mean value 2.1 to 2.3 in all tissues studied. This ratio was changed by radiotherapy to 2.9 in tumor tissue, but not in surrounding irradiated normal tissue. The effect on tumor oxygen tension of the radiosensitizer Synkavit was negligible, but heating of tumor by diathermy markedly reduced both resting levels of oxygen tension and the response to oxygen breathing. Data from anemic patients showed the importance of correcting this condition before radiotherapy if high oxygen tensions are to be obtained in the tumors. (BBB)

19383 SOME ASPECTS OF THE BIOCHEMICAL BASIS OF THE BIOLOGICAL ACTIONS OF X RAYS. Melching, H.-J. (Univ., Freiburg i. B.). pp 196-208 of The Treatment of Cancer, With Special Reference to Radiotherapy and Chemotherapy. Mitchell, J. S. (ed.). Cambridge, Eng., University Press, 1965.

Studies on the importance of vitamin B_6 in irradiated organisms and the radioprotective effect of 5-hydroxytryptamine (serotonin) are reviewed. It was observed that although vitamin B_6 (pyridoxine) itself did not influence the disturbances caused by irradiation in metabolically active mammalian tissues, pyridoxal 5-phosphate played an important role. The excretion of tryptophan metabolites in the urine of mice was increased while the excretion of taurine was decreased. The hypothesis was put forward that there was a disturbance in pyridoxal 5-phosphate acting as an enzyme pros-

thetic group which was caused by irradiation. This was based on the findings that transformation of kynurenine to anthranilic acid was inhibited, therefore the excretion of kynurenic acid increased; transformation of 3-hydroxykynurenine to 3-hydroxyanthranilic acid was likewise inhibited, so that the excretion of xanthurenic acid was increased; and transformation of cysteinesulfinic acid to hypotaurine was inhibited and the excretion of taurine decreased at the same time as the excretion of kynurenic acid and xanthurenic acid was increased. From the point of view of enzyme kinetics, the increase of the excretion of kynurenine and its metabolites indicated that in the mouse after irradiation the concentration of kynurenine became so large that the turnover rate of the catabolic enzyme systems could no langer carry out normal transformation of kynurenine and therefore the excretion was increased. On the other hand, kynurenine was a substrate of kynureninase (with pyridoxal 5-phosphate as coenzyme) as well as for the kynurenic-acid-forming enzyme systems. The maximum increase of kynurenic acid caused by irradiation amounted to nearly 200%, while the increase of anthranilic acid was only about 50%. The observation of an increased supply of tryptophan metabolites after irradiation indicated that there was a general disturbance of the utilization of tryptophan, probably due to a reduced incorporation of this amino acid into protein as occurred in deficiency of vitamin B_6. The increased activity of tryptophan peroxidase in the liver of rats after irradiation could be a consequence of the increased supply of tryptophan. After local irradiation of the liver with 300 R the excretion of xanthurenic acid increased seven fold and the excretion of anthranilic acid decreased 50%. These experiments provide additional confirmation that disturbance in kynureninase and pyridoxal 5-phosphate was caused by irradiation. (BBB)

19384 AN ATTEMPT TO DEVELOP A RADIOACTIVE DRUG FOR CANCER CHEMOTHERAPY. **Marrian, D. H.; Marshall, Barbara; Mitchell, J. S.; Simon-Reuss, Irmelin (Univ. of Cambridge, Eng.).** pp 98-130 of **The Treatment of Cancer, With Special Reference to Radiotherapy and Chemotherapy. Mitchell, J. S. (ed.). Cambridge, Eng., University Press, 1965.**

Organic compounds were developed which were concentrated or absorbed selectively by the cells of malignant tumors and carried incorporated radioactive atoms in high specific activity. After intravenous injection of tetra-sodium 2-methyl-1,4-naphthaquinone diphosphate (Synkavit, Compound I), which was being studied as a chemical radiosensitizer, it was found that this compound concentrated selectively in certain human tumors and in the Walker rat carcinoma. Tritium appeared to have the most satisfactory chemical and radioactive properties for labeling. A new method of tritiation was devised which made it possible to obtain reliable preparations of the compound containing one atom of tritium per molecule. Compound I incorporating tritium in the six-position was prepared and named TRA 72. Since the maximum energy of tritium β particles was 18.6 keV, their maximum range was about 6 μ, which was less than the diameter of most human cells. The average energy of the β particles was of great importance in radiotherapy, and in a calorimetric determination was found to have the value of 5.73 ± 0.03 keV. The range of the β particles in tissues corresponding to the mean energy was about 0.9 μ. The radiation dose rates and isodose curves about a point source of tritium were determined, indicating that the biological action of the tritium should be localized within the cells which incorporated the carrier molecules. The sparing of the normal cells was one of the advantages which the use of a tritiated drug, with the property of some degree of selective concentration in tumor cells, had over the use of radioactive particles as microemboli. A diuretic regime was used after the administration of tritiated Compound I, to try to minimize the effects of its metabolites, possibly including tritiated water, upon the normal tissues, by reducing the values of the corresponding biological half-lives. It was noted that with selectively absorbed tritiated drugs, the biological half-life had different values in the tumor and in the various normal tissues. For the tritium of tetra-sodium 2-methyl-1,4-naphthaquinonne diphosphate, the values of the main biological half-life for the malignant tumors and tissues of treated patients were shown. The value of the main biological half-life was probably ~13 days for some tumors, though great variation was likely and values as low as three to four days were found. The problem of the value of the RBE used in this investigation was discussed. Experimental evidence suggested a value of 1.7 for the RBE of tritium β particles in relation to ^{60}Co γ radiation was valid. Calculations of the approximate dose of radiation delivered by the tritium on the basis of measurements of the specific activity in millicuries per g of tumor or tissue and the biological half-life involved were given. Clinical results with TRA 72 were described. The limited evidence from investigation of 48 patients, nearly all of whom were seriously ill with advanced, recurrent, radioresistant, or refractory malignant disease, suggested that the therapeutic application of tritiated Compound I produced useful palliation in at least 13 cases. With the amounts so far used of up to 8 Ci in a single intra-arterial injection, there appeared to be little or no risk of serious damage to the bone marrow. With the purified preparations, depression of the levels of hemoglobin and of the total and differential leucocyte counts and platelet count were minimal. There was no evidence of radiation damage to the gastrointestinal tract. (BBB)

19385 ASPECTS OF CLINICAL TRIALS. **Brinkley, Diana; Haybittle, J. L. (Cambridge Univ., Eng.).** pp 135-53 of **The Treatment of Cancer, With Special Reference to Radiotherapy and Chemotherapy. Mitchell, J. S. (ed.). Cambridge, Eng., University Press, 1965.**

The organization of a clinical trial for testing radiosensitizers is described. The trial was divided into two parts: Part I tested radiosensitizers in patients with inoperable carcinoma of the lung who had had a thoracotomy; and Part II tested radiosensitizers in similar patients but who had not had a thoracotomy. Four radiosensitizers were tested in conjunction with a modified radical course of radiotherapy: oxygen administered at atmospheric pressure by means of a mask at the rate of 6 to 8 l/min, starting 20 min before and continuing throughout the whole period of irradiation on each day of treatment; oxygen as in (1) combined with intravenous injection 30 min before x-ray treatment of tetra-sodium 2-methyl-1,4-naphthohydroquinone diphosphate (synkavit); synkavit injected intravenously without administration of oxygen; and tetra-sodium 2,3-dimethyl-1, 4-naphthohydroquinone diphosphate (Compound 28) injected intravenously 30 min before x-ray treatment, without administration of oxygen. In the first part of the trial only sensitizers were being tested. In all patients entered, the histology had to be positive with no evidence of extrathoracic spread. In Part II of the trial there were four groups of patients, each group having x-ray therapy with one of the radiosensitizers listed above. (BBB)

19386 CURRENT EXPERIENCES WITH ^{99m}Tc FOR FUNCTIONAL AND MORPHOLOGICAL THYROID DIAGNOSIS. **Hennig, K.; Woller, P.; Wagner, G. (Radiologische Klinik, Dresden).** Deut. Gesundheitsw., 21: 2080-5(1966). (In German).

The particular advantage in the use of ^{99m}Tc for thyroid diagnosis was the very small amount of irradiation received from it by the patient. For a thyroid of 30 g, with an uptake of 10% of an administered dose of 1 mCi, the irradiation exposure amounted to ~1 rad. This exposure was less by a factor of ~100 than the exposure received from the dose of ^{131}I usually given for scintigraphy. The whole-body irradiation received from 1 mCi of ^{99m}Tc was 11 mrad, while the dose to the large intestine as the critical organ was ~210 mrad. Doses of the order of 1 mCi were usually adequate for studies of thyroid function and morphology. (BBB)

19387 EXPERIMENTAL DATA ON CYSTEINE–COPPER INTERACTION DURING RADIOPROTECTION. **Nicolau, Cl.; Grigorescu, St.; Nastase, M.** Radiobiol. Biol. Mol., 97-103 (1967). (In Rumanian).

In an attempt to elucidate some aspects of the chemical radioprotective mechanism, the cysteine-copper interaction was studied in vitro and in vivo. Cysteine given to rats (800 mg/kg) was found to produce an increase in Cu-plasma binding ability and, simultaneously, it diminished serum ceruloplasmin activity. That effect was present in the first 2 to 3 hours and disappeared 24 hours after cysteine administration. Electron paramagnetic resonance spectra and optical absorption spectra account for the phenomena, emphasizing the catalytic intervention of cysteine in the reaction between Cu and plasma. The results indicate the importance of the direct activity of the protective substance molecule on biological molecules in chemical radioprotection mechanisms. (Romanian Sci. Abstr.)

19388 TRANSPLANTATION OF PRESERVED BONE MARROW IN TREATMENT OF EXPERIMENTAL ACUTE RADIATION SICKNESS. **Kevlishvili, G.; Egnatashvili, Sh. V.; Abesadze, A. I.; Tkeshelashvili, T. V. (Scientific Research Inst. of Blood Transfusion, Tbilisi, USSR).** Probl. Gematol. Pereliv. Krovi, No. 10, 37-9(Oct. 1966). (In Russian).

Dogs were x-irradiated with fatal doses (600 R) and then treated two days later with bone marrow alone or combined with a protein blood substitute, the colloid infusin or food gelatin. The bone marrow transplants were helpful in restoring the hematological indices, but the effect was greatly enhanced when the blood substitutes were used. The latter also increased the survival rate. Of 15 animals treated with bone marrow alone, seven survived compared with eight of 10 and 11 of 15 treated with the addition of infusin and gelatin, respectively. All 20 control animals died. (JPRS)

19389 TREATMENT OF VIRAL INFLAMMATION OF THE CORNEA BY UV IRRADIATION. Koleszar, Gy.; Molnar, L.; Juhasz, L.; Tatrai, K.; Torok, I. (Hajdu-Bihar Megye Council Hospital, Budapest). Orv. Hetil., 107: 1518-19(Aug. 1966). (In Hungarian).

The use of uv radiation in the treatment of superficial and deep processes of the cornea caused by the herpesvirus was described on the basis of 21 cases. The treatment led to healing within an average of 13.9 days in the case of superficial processes and within 24.5 days in the case of more deep seated ones. (JPRS)

19390 A NEW RADIOISOTOPE INTESTINAL ABSORPTION TEST BY THE LINEAR SCANNING. I. Yamaguchi, Keizo; Okawa, Haruo (Chiba Univ., Japan). Nippon Shokakibyo Gakkai Zasshi, 63: 605-11(June 1966). (In Japanese).

In the radioisotope intestinal absorption test using ^{131}I-labeled triolein (100 μc) as a tracer, linear scanning was employed, in addition to measurements of the change of blood concentration and excretion ratio into feces. The extent to which the wave pattern of linear scanning could show the function of intestinal absorption was investigated. Linear scanning was conducted successively after oral administration of the radioisotope. Where there were no absorptive disturbances, a point source was shown at the xiphoid process after two hours, and some waves were also observed after four hours at the umbilical and pubic regions. After six hours the peak of wave shifted from the xiphoid process to the umbilical and pubic regions, and after eight hours a peak of wave appeared at the pubic region accompanied by several other small waves. With absorptive disturbances, the above change of the wave pattern was retarded, in comparison with that of normal cases. A positive correlation was observed between the degree of absorptive disturbances obtained by the wave pattern of linear scanning, the maximal blood concentration of radioisotope, and the excretion ratio of radioisotope into the feces. (NSA of Japan) (TSS)

19391 EXPERIENCE WITH MEGAVOLTAGE IRRADIATION OF ADVANCED MALIGNANT DISEASE USING HIGH PRESSURE OXYGEN. van den Brenk, H. A. S.; Madigan, J. P.; Kerr, R. C. (Cancer Inst. Board, Melbourne). pp 144-60 of Clinical Application of Hyperbaric Oxygen. Boerema, I.; Brummelkamp, W. H.; Meijne, N. G. (eds.). Amsterdam, Elsevier, 1964.

Radiobiological observations are reported for a clinical study of the effects of high pressure oxygen (HPO) combined with treatment with a 4-MeV linear accelerator. In 250 patients a total tumor dose was delivered in 2 to 3 large fractions (800 to 1000 rad), all fields being treated during a single pressurization at 45 to 60 psi, with 7 to 14 days elapsing between fractions. In a discussion of radiation reactions in HPO, emphasis is placed on the dose effectiveness in terms of cell survival for both tumor and normal tissues; otherwise comparison of tissue reactions and therapeutic ratios for various treatment policies (fractionated or otherwise) is valueless. The only useful comparison found between tissue reactions in air and HPO was for 3×1000 rad and the HPO values for calculated cell survival, $n/n_0 = 10^{-9}$. In the treatment of buccal cancer, resulting in skin, connective tissue, and mucous membrane reactions, the incidence of necrosis in normal tissues and the tumor bed was similar with and without HPO. These radiation reactions were severe, and possibly worse with HPO than with air but this was attributable to more rapid and thorough eradication of the tumor, resulting in a larger tissue deficit. The incidence of necrosis normal tissue irradiated in the presence of HPO did not exceed that for air treatments for comparable irradiated volumes and for comparable values of n/n_0. Accurate tumor response data in certain sites (brain, pelvis, lung) was much more difficult to obtain. For 1000-rad fractions used to treat abdominal and pelvic tumors, if only 7 days separated such fractions, lethal acute intestinal damage often resulted (both in air and HPO). On the other hand, if 14 days separated the fractions, morbidity was greatly reduced and usually only mild diarrhea resulted, an improvement due to repopulation of intestinal mucosa for the longer intervals of 14 days. Ulcerating bronchial cancer, after radical destruction by irradiation in HPO (or air) resulted in bronchial or esophageal hemorrhage or stenosis and produced high morbidity. (BBB)

19392 WHOLE-BODY COUNTING IN METABOLIC STUDIES OF ^{131}I-LABELED ALBUMIN. Rossing, N.; Baerenholdt, O. (Glostrup Hospital, Copenhagen). Scand. J. Clin. Lab. Invest., 19: 331-8(Aug. 1967).

Construction and use of simple whole-body counting equipment suitable for metabolic studies of ^{131}I-labeled proteins are described. It was shown that it is possible to correct with satisfactory accuracy for the change in self-absorption during such studies. The whole-body counter consists of a stationary canvas bed placed in a mobile double-walled hollow iron cylinder. The cylinder has an ID of 80 cm and a length of 60 cm. Its inner wall is covered with 5 mm lead providing the scintillation crystals with a shadow shielding. In the middle of the wall of the cylinder, 120° apart, are three detectors with $1\frac{3}{4} \times 2$ in. NaI(Tl) crystals. Each crystal is surrounded by an extra dome-shaped lead shielding. This arrangement provides a close approximation of the 4π geometry. In metabolic studies with ^{131}I-labeled albumin, due to redistribution of the tracer, the self-absorption changes during the study. This may compromise the results. It is possible to calculate the change in self-absorption by comparison of the whole-body measurements with the retained activity calculated from the urinary excretion of activity. Self-absorption was shown to be constant after three days. The initial change was assumed to be caused by transfer of the tracer from the intravascular compartment. Initially the self-absorption was on an average 7.3% higher than subsequently. When the height and weight of the subjects were taken into account, it was possible to correct for change in self-absorption with an accuracy of 1.8%. When corrected whole-body countings were used, it was possible to omit urine collections. (BBB)

19393 RADIOSENSITIVITY AND TOTAL CONTENT OF SULPHHYDRYL GROUPS IN HEMOPOIETIC TISSUES OF MAMMALS. Le Suan Tu; Graevskii, E. J. Dokl. Akad. Nauk SSSR, 175: 227-9(July 1, 1967). (In Russian).

Experiments were carried out to determine the correlation between the radiosensitivity of rats and the overall mercapto-group content of the bonemarrow tissues of the animals. Five days before irradiating the animals by a single x ray dose of 500, 600, 700, 800, or 900 R, one hind limb of the male rats used for the tests was removed, and the SH-content of the bone marrow was determined by amperometric titration with a 0.001 M solution of mercuric chloride. The SH concentrations and the $LD_{50/30}$ survival rate data were correlated by means of D. Y. Finney's Probit analysis. It was found that at all dose levels used, the death rate of rats with a lower SH content of the bone marrow was higher than that of rats with a higher content of mercapto-groups. The results indicated that animals possessing higher thiol content of the blood-forming organs that determine their viability at mean lethal doses, exhibited a lower degree of radiosensitivity. Thus, the mercapto-group content was probably responsible for the degree of radiosensitivity of the organism and the cell. (TTT)

19394 EFFECT OF PROTECTIVE ANTIRADIATION PREPARATIONS ON BRAIN TISSUE AMMONIA CONTENT IN RATS. Strelkov, R. B. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Vop. Med. Khim., 13: 76-8(1967). (In Russian).

Experiments were conducted on 163 white rats that weighed 165 to 240 g. Both males and females were used and experiments took place at the same time of day. The following radioprotective drugs were studied: cystamine, 150 mg/kg; BMEA, 150 mg/kg; AET, 200 mg/kg; thiourea, 2250 mg/kg; unithiol, 350 mg/kg; 5-methoxy-tryptamine, 20 mg/kg; and serotonin, 25 mg/kg. Camphor and NH_4Cl were used to stimulate the CNS. Animals were killed by immersion in liquid nitrogen and oxygen. It was found that cystamine, BMEA, AET, thiourea, and unithiol had no effect, while serotonin and 5-methoxytryptamine decreased the ammonia content of brain tissue. (ATD)

19395 THE EFFECT OF TELECOBALT IRRADIATION ON THE PRIMARY LESION OF UTERINE CERVIX CANCER. Kaneda, Ryoichi (Iwate Medical Coll., Japan). Nippon Sanka Fujinka Gakkai Zasshi, 18: 201-10(Mar. 1966). (In Japanese).

The changes in the primary lesion of uterine cervix cancer that were caused by telecobalt irradiation was studied macroscopically, histologically and electron-microscopically. The subjects were divided into two groups, an A-group that received total tumor doses of 4000 R with 100R/1 time (300R/1 time alternately to each of the bilateral B-points by pendulum irradiation at 220 degrees), and a B-group that received total tumor doses of 6000 to 75000 R with 300 R/1 time (rotation irradiation with the uterine cervix as a center). Macroscopic observation revealed that with the increase of dose the flattening of the ulcer surface, shrinkage of the lesion, decrease of bleeding, formation of a crust, and cicatrization occurred. There was not much difference between A- and B-groups, but the change occurred earlier in the B-group and to those reviewing the higher dose in the A-group. The improvement was apparently larger in the B-group. In the histological observation, vacuolar degeneration, pyknosis and karyorrhexis were seen from 800 R in the A-group, and from 1200 R in the B-group. The proliferation of interstitial connective tissue was found from 2400 R in the A-group and from 3600 R in the B-group. In one-third of the cases of the A-group, re-proliferation of cancer cells was found after irradiation at 4000 R, but in the B-group this was not observed, there were no cases in

which cancer cells completely disappeared. In the electron-microscopic observation, the A-group mitochondria became cicatricial and electron-dense osmic acid-phile-granules increased from 2400 R. Above 3200 R, some cancer cells appeared whose mitochondria and endoplasmic reticulum re-developed and whose osmic acid-phile granules in the cytoplasm decreased. In the B-group, the regressive degeneration of mitochondria and endoplasmic reticulum of cancer cells became marked when the radiation dose was increased and the cancer cells were intensively destroyed. (NSA of Japan)

19396 MODIFICATION OF RADIOPROTECTIVE 2-AMINOETHANETHIOL DERIVATIVES BY N,N'-POLYMETHYLENE BRIDGING. Piper, James R.; Stringfellow, Carl R. Jr.; Johnston, Thomas P. (Southern Research Inst., Birmingham, Ala.). J. Med. Chem., 9: 563-6(July 1966).

Since S-2-aminoethylthiosulfuric acid and the corresponding phosphorothioic acid protect against lethal doses of radiation, N,N'-polymethylene bridging of two like units of these compounds was undertaken for evaluation of the effect of such combination on their radioprotective properties. Thus compounds of the type $HO_3SSCH_2CH_2NH(CH_2)_nNHCH_2CH_2SSO_3H$ (I, n = 2–6) and $MHO_3PSCH_2CH_2NH(CH_2)_nNHCH_2CH_2SPO_3HM$ (II, n = 2, M = Li; n = 3–6, M = Na) were prepared from the bromo mustards $BrCH_2CH_2NH(CH_2(NHCH_2CH_2Br \cdot 2HBr$ (III n = 2–6) for evaluation as radioprotective agents. Four of the key intermediates III (n = 3–6) were prepared via a facile route involving treatment of N-(2-hydroxyethyl)-p-toluenesulfonamide with α,ω-dibromoalkanes followed by detosylation of the resulting N,N'-polymethylenebis-N-(2-hydroxyethyl)-p-toluenesulfonamides (n = 3–6) with concomitant tant bromodehydroxylation in refluxing 48% HBr. Blocking of the amino groups was essential in the steps leading to III (n = 4 and 5) in order to preclude competitive cyclization reactions. Treatment of III with appropriate thioanions afforded I and II. Two of the phosphorothioates II (n = 3 and 4) showed good radioprotective activity in mice. The results showed that the radioprotective activity of S-2 aminoethylthiosulfuric acid was all but negated by simple N,N'-polymethylene linkage; the slight activity shown by I (n = 5) suggested that a long methylene bridge might be requisite for appreciable activity. On the other hand, the same modifications of S-2-aminoethylphosphorothioic acid allowed good retention of activity if the connecting chain was limited to three or four methylene groups. (BBB)

19397 INCREASE OF RADIORESISTANCE IN POTATOES DURING ANOXIA. Dadykin, V. P.; Shaydorov, Yu. I.; Gertsuskii, D. F.; Skukina, I. S.; Nikishanova, T. I.; Nikitina, I. V.; Finogenova, L. I. Kosm. Biol. Med., 1; 36-40(1967). (In Russian).

Experiments were performed on the radioprotective effect of anoxia on month-old potato seedlings. Khibinsk-type potatoes were grown in flat, hermetically sealable, vinyl plastic boxes. After 30 days, when the seedlings reached a height of 5 to 10 cm, the boxes were sealed and the air was replaced by a nitrogen atmosphere in one group and an oxygen atmosphere in a second group. A third, control group remained in normal air. Eighteen hours after the normal atmosphere was replaced by nitrogen (or oxygen), the potato seedlings were exposed to gamma irradiation using an EGO-20 unit (at a dose rate of 747 rad/min). Two hours after irradiation, the nitrogen (or oxygen) atmosphere was replaced by normal air. On the following day, the plants were planted 50 cm apart in normal garden soil. A row of 25 plants was used for each atmospheric variant. The experiment was performed three times. Irradiation tended to retard growth of both stems and leaves, especially in plants irradiated in an oxygen atmosphere. Irradiation by 500 and 1500 rad resulted in insignificant differences. Doses of 3000 and 5000 rad showed a radioprotective effect of anoxia. Plants exposed to 3000 rad in a nitrogen atmosphere produced four times as many potatoes as those irradiated by a similar dose in an oxygen atmosphere. More than half of the plants irradiated by 3000 rad in an oxygen atmosphere failed to produce any crop. None of the plants which had been exposed to 5000 rad in an oxygen atmosphere produced any crop, while 10 out of 25 plants irradiated by 5000 rad in a nitrogen atmosphere produced tubers. Plants irradiated by 3000 rad in a nitrogen atmosphere produced potatoes with a 50% higher starch content and a 30% higher ascorbic acid content. The results indicate that anoxia has a definite radioprotective effect on potatoes and that by further research in this area it may be possible to protect plants in spaceship greenhouses from large doses of ionizing radiation, such as solar flares. (ATD)

19398 EFFECT OF TRIIODOTHYRONINE IN EXCESSIVE DOSE ON THE GROWTH AND RADIOSENSITIVITY OF TUMORS IN MICE. Shima, Takayoshi (Tottori Univ., Japan). Yonago Acta Med., 11: 123-6(1967).

A study of the effect of large doses of l-triiodothyronine (T_3) on the growth and radiosensitivity of mouse tumors showed that the mitotic rate of Ehrlich ascites carcinoma cells was decreased by injection of 20, 30, and 40 μg per mouse. The growth rate of spontaneously occurring mammary tumors transplanted in C_3H mice was decreased by injections of 20 μg of T_3 every other day. Reduction of the mitotic rate of Ehrlich ascites carcinoma cells in mice caused by x irradiation was suppressed by injection of 20 μg of T_3 immediately before irradiation. The suppressive effect of irradiation on the growth of spontaneously occurring mammary tumors transplanted in C_3H mice was enhanced slightly by injection of 20 μg of T_3 immediately before irradiation. It is suggested that a large dose of T_3 may be useful as an adjunct to radiation therapy of malignant tumor. (BBB)

19399 RADIATION CHIMAERAS. van Bekkum, D. W.; de Vries, M. J. Radiobiological Institute of Organisation for Health Research TNO, Rijswijk Z.H., Netherlands. London, Academic Press, 1967. 287p. 75s.

The radiation chimaera is defined as an animal which carries a foreign haemopoietic system, as a result of whole body irradiation followed by transplantation of haemopoietic cells derived from another animal. This monograph reviews the literature on the subject up to early 1965. Research at Rijswijk is described, with emphasis on bone marrow transplantation in irradiated animals and the pathology of secondary disease. Applications for haematology, organ transplantation, and the treatment of leukaemia are discussed. Many illustrations are included in the book. Section headings are as follows: History of the radiation chimaera; production of radiation chimaeras and stability of the chimaeric state; secondary disease following bone marrow transplantations; pathology of the radiation chimaera; immunological studies with radiation chimaeras; clinical applications of bone marrow transplantation and related experiments. 473 references. (UK)

Radiation Effects on Animals

Refer also to abstracts 19239, 19241, 19243, 19244, 19251, 19258, 19267–19269, 19277, 19278, 19289, 19295, 19300, 19306, 19308, 19314, 19315, 19325, 19326, 19349, 19354, 19355, 19358, 19361, 19363, 19364, 19370, 19373, 19378, 19381, 19383, 19391, 19393, 19398, and 19459.

19400 (BNWL-531-1) INDUCED RADIONUCLIDES IN ASTRONAUTS. Quarterly Activity Report, July 1–October 1, 1967. Perkins, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 8, 1967. Contract AT(45-1)-1830. 21p. Dep. CFSTI.

An estimate of radionuclides that would be produced in an astronaut during a two-day orbital flight is tabulated. The calculations were based on spallation or capture reactions for protons with energies from 100 to 600 MeV. A list is presented of methods of production by cosmic radiation of radioisotopes of Ar, Be, Cl, Cu, K, Mg, Mn, Na, Rb, S, and Si. Tissue equivalent solutions that contained O, C, H, N, Ca, P, S, K, Na, Cl, Mg, Fe, Rb, Cu, and Mn at the concentrations present in a standard man were prepared by using chelating agents. The tissue equivalent solutions were bombarded with 14 MeV neutrons, 4 MeV neutrons, thermal neutrons, and natural cosmic radiation at 60,000 to 63,000 ft and provided a qualitative picture of the radioisotopes produced by the various neutron capture and spallation reactions. The data are tabulated. (H.L.W.)

19401 (EUR-3885) SVILUPPO IN VIVO E IN VITRO DI ORGANI EMBRIONALI E AZIONE DEI RAGGI X. Relazione Biennale, 1965–1966. (Growth in vivo and in vitro of Embryonic Organs and Action of X Rays. Biennial Report, 1965–1966). Borghese, E. (Naples Univ. (Italy). Istituto di Anatomia Topografica). Dec. 6, 1967. Contract 043-65-1 BIOI. 14p. Dep.

The research carried out in the two years 1965–1966 concern: the reconstruction of the nephron of an elasmobranch, Scyliorhinus stellaris, where the presence was demonstrated of a portion of the renal tubule formed of a thin dorsal loop, not yet described (Borghese); the development of a mouse lung in vitro, with a study by quantitative methods of its rate of growth in vitro under various experimental conditions represented by changes of the normal epithelium/mesenchyme ratio, and the inhibition of development under the action of x rays in doses of 50–400 R (Alescio, Colombo Piperno); the appearance in vitro of the pulmonary tree (Dani); the age at which secretion of the submandibular and sublingual glands appears in the mouse embryo, its histochemical characteristics, and the inhibition of growth of the submandibular gland under the effect of x rays in doses of 100–500 R (Di Giovine Vecchione, Borghese); the appearance of perichondral ossification in in vitro

cultures of mouse-limb cartilages (Mazza); the in vitro reassociation of embryonic tissues and organs. (auth)

19402 (NP-16717) EFECTO DE LAS RADIACIONES IONIZANTES SOBRE EL VOLUMEN SANGUINEO Y SUS COMPONENTES. (Effects of Ionizing Radiation on Blood Volume and Its Components). Najar Joa, Manuel (Universidad Nacional Autonoma de Mexico, Mexico City). 1966. 83p. (In Spanish). Dep.

Thesis.

The blood volume in patients with stage III mammary cancer and the variations during the period of radiotherapy in 11 of the 15 total cancer patients were studied. A pre-irradiation control determination of the blood volume and its components was made and these values were followed for periods up to 15 days after therapy. In the control determination the blood volume and the plasma volume were within the normal limits but with a tendency to be at the lower limit. The cell mass is within the normal limits in the controls when it is calculated for ideal weight. Exposure of the patients to radiotherapy causes variations in the total blood volume, the cell mass, and the plasma volume. A typical response was found neither in the plasma volume nor in the total blood volume. A typical variation of the cell mass was not observed. It cannot be inferred from the results that ionizing radiations interferred with hematopoiesis or the homeostasis of the cell mass. (tr-auth)

19403 EXPERIMENTAL Q-SWITCHED RUBY LASER RETINAL DAMAGE. Zweng, R. C.; Rosan, R. C.; Peabody, R. R.; Shuman, R. M.; Vassiliadis, A.; Honey, R. C. (Palo Alto Medical Research Foundation, Calif.). Arch. Ophthalmol. (Chicago), 78: 634-40 (Nov. 1967).

A Q-switched ruby laser was tested for induction of retinal lesions in rabbits and monkeys, with special attention being given to elimination of inhomogeneities from the portion of the laser beam entering the eye; correction of each eye for refractive error to produce minimal retinal impact area; estimation of the retinal area impacted; monitoring of the laser output in space, time, and amplitude; and detailed clinical and pathological effects. Eight μJ in pigmented rabbits and 22 μJ in rhesus monkeys for 8-nsec pulses gave a 50% probability of producing a clinically observable lesion. Histologically, lesions were seen at about half this level. Energy density or power density at the retina was the determining factor for threshold damage. Histologically, the glial reaction was conspicuously deficient. However, instances of local pigment-cell hyperplasia were observed. (BBB)

19404 ACCIDENTAL Q-SWITCHED LASER LESION OF HUMAN MACULA. Zweng, H. Christian (Palo Alto Medical Clinic, Calif.). Arch. Ophthalmol. (Chicago), 78: 596-9 (Nov. 1967).

A case report involving the accidental exposure of a human macula to a Q-switched ruby laser is presented. A scientist in a university physics laboratory sustained an exposure to his right macula during an experiment involving the interaction of a laser beam with various materials to produce stimulated Raman and Brillouin scattering. The accident illustrates a situation in which safeguards were observed, but only with regard to the laser beam itself. The retinal damage that resulted was produced entirely by secondary stimulated effects in directions noncollinear with the laser beam. Part of the scattered energy was unexpectedly reflected from a bottle on a shelf into the right eye. A reconstruction of the accident, using a laser calorimeter in place of the eye indicated that the energy that had entered the eye had been between 1 and 3 mJ. Almost immediately the scientist noted a paracentral scotoma. At 19 hr after exposure his best corrected visual acuity in the exposed eye was 20/25 and J1 with difficulty, and 20/15, and J1 with ease in the other eye. He demonstrated a macular lesion, seeming to involve the fovea. An Amsler grid showed blurring of the grid just to the right of the fixation point. He was treated intramuscularly with 80 units of corticoptropin. (BBB)

19405 RADIATION NEPHRITIS OF ECTOPIC KIDNEYS. Amar, Arjan D. (Kaiser Foundation Hospital, Walnut Creek, Calif.). Obstet. Gynecol., 30: 118-20 (July 1967).

Risks from radiation therapy to ectopic kidneys are discussed, and a case is described here in which bilateral ectopic (pelvic right and sacroiliac left) kidneys received ionizing radiation supplemental to complete surgical removal of pseudomucinous cystadenocarcinoma of both ovaries. That the kidneys were ectopic was unknown before radiation therapy, and this resulted in radiation nephritis. Deep x ray therapy in excess of 4000 R was given to the pelvis during the postoperative period. During the ensuing 5 years the patient developed chronic uremia with blood urea nitrogen levels ranging from 35 to 45 mg/100 ml. Retrograde urography revealed bilateral renal ectopia and short ureters, congenital ureteropelvic junction obstruction, and right hydronephrosis. At operation to remove recurrent ovarian carcinoma of the pseudomucinous type, biopsy of the left kidney showed radiation nephritis. The function of the right kidney had been impaired originally by congenital obstruction at the ureteropelvic junction; presumably radiation damage further diminished its function and markedly reduced the function of the left kidney as well, leading to uremia and anemia. Manifestations of acute radiation nephritis (hypertension, anemia, edema, and proteinuria) usually begin to appear after a latent period of 6 to 13 months. Recommendations are made for performance of excretory urography before delivering therapeutic doses of radiation to the pelvis. The discovery of ectopic kidneys would then suggest withholding radiation therapy. Such a study would also establish base-line information so that if urinary obstruction, reduced renal function, or both were to develop subsequently, the probability of neoplastic involvement or radiation injury of the urinary tract can be judged with greater accuracy. (BBB)

19406 EFFECT OF ELECTROMAGNETIC RADIOFREQUENCY FIELDS ON THE PHAGOCYTOSIS AND THE COURSE OF INFECTIOUS INFLAMMATION IN RATS. Volkova, A. P.; Smurova, E. I. (Inst. of Industrial Health and Occupational Disease, Moscow, Gorky Inst. of Industrial Health and Occupational Disease, USSR). Gig. Sanit., 9: 107-10 (Sept. 1967). (In Russian).

A total of 57 rats was divided into three groups. The first group of 25 rats was subjected to irradiation for six months (168 sessions of one hr per day). A second group of 18 rats was subjected to irradiation for 2.5 months (66 sessions), and then they were rested for 3.5 months. In both groups one-third of the rats were subjected to short-wave irradiation; another third to very short-wave irradiation, and the final third to ultra-short-wave irradiation. A group of 14 controls was used to judge the inflammatory response to the intracutaneous introduction of 825 million cells of Escherichia coli. An inflamed area 5 mm in diameter represented a weak inflammatory response. A diameter of up to 1 cm represented a moderate response, and a diameter above 1 cm represented a high inflammatory response. Rats subjected to short-wave irradiation showed the greatest shifts in the phagocytic reaction due to a decrease in the number of neutrophils and to a decrease in their phagotizing ability. The bacteriocidal properties of the plasma were at a high level due to the inflammatory response of the organism. (TTT)

19407 CHEMICAL BLOOD ANALYSIS AFTER IRRADIATION WITH ^{60}Co GAMMA RADIATION AND 35-MeV ELECTRON BEAMS. Ott, A. (Sonderabteilung fuer Strahlentherapie, Vienna). Fortschr. Geb. Roentgenstr. Nuklearmed., 107: 533-40 (Oct. 1967). (In German).

Results are reported on chemical blood tests taken after irradiation with ^{60}Co gamma radiation and 35 MeV electrons. Those patients who had telecobalt irradiation showed an increase of cholesterol as well as of calcium magnesium potassium in the blood. After irradiation with the betatron, however, the majority of patients examined showed a clear decrease of cholesterol, calcium, potassium and magnesium. These favorable chemical reactions together with other factors of radiation physics are without doubt the reason for a better tolerability of therapy with high energy electrons. (auth)

19408 RELATIVE BIOLOGICAL EFFICIENCY OF VARIOUS TYPES OF IONIZING RADIATIONS. (INJURIES OF TESTES AND THE RATE OF INCIDENCE OF DOMINANT LETHAL MUTATIONS IN THE GONAD CELLS IN MICE). Pomerantseva, M. D.; Ramaiya, L. K. Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 162-76 (1965). (In Russian).

The study of different types of irradiation has shown that in the rate of incidence of dominant lethal mutations in mature spermatozoa and in the degree of damage to mouse testes fast neutrons were five to six times as effective as gamma rays and almost four times as effective as x rays. Protons of 660 MeV were approximately $\frac{1}{2}$ as effective as x rays. RBE of protons to gamma rays was 0.6 to 0.7. Genetically the spermatids proved to be 2.5 times more radiosenstive than spermatozoa, when irradiated with protons and gamma rays, and 1.8 times, when irradiated with fast neutrons. The proportion of the number of mutations causing death of embryos before and after implantation was the same with all types of irradiation. (auth)

19409 POST IRRADIATION CHANGES IN THE NERVE STEM CELLS OF CHICKEN EMBRYOS. Puchkov, V. F. (Inst. of Experimental Medicine, Leningrad). Radiobiologiya, 7: 556-61 (1967). (In Russian).

Two-day-old hen's eggs were totally irradiated with 400 R and sections were prepared of embryos 1 to 8, 12, 18, 26 and 48 hours after irradiation. The morphology, dynamics and origin of the granules appearing in the nerve stem cells in the early days after

irradiation were studied. Drawings were made of three different types of granules: pyroninophilic; pyroninophilic with a chromatin component; and degenerating cells and granules containing DNA (residues of dead cells). As regards their origin, the results obtained testify in favor of the hypotheses advanced by Sauer and Dungan. (JPRS)

19410 IMMUNOLOGIC CONCEPTS OF LIGHT REACTIONS IN LUPUS ERYTHEMATOSUS AND POLYMORPHOUS LIGHT ERUPTIONS. I. THE MECHANISM OF ACTION OF HYDROXYCHLOROQUINE. Lester, R. S.; Burnham, T. K.; Fine, G.; Murray, K. (Henry Ford Hospital, Detroit, Mich.). Arch. Dermatol., 96: 1-10(July 1967).

The effect of uv irradiation in several photosensitive diseases was studied, as well as its ability to modify the effects of some antimalarial drugs on the uv-induced reactions. The 64 patients were tested with uv to determine the relations between systemic and discoid lupus erythematosus (SLE, DLE) and polymorphous light eruption (PMLE) in immunopathologic responses to light. The effects of intradermal hydroxychloroquine sulfate (Plaquenil), methylprednisolone sodium succinate (Solu-Medrol), methotrexate, and topical applications of hydroxychloroquine and saline on cutaneous responses to uv light were examined. There was significant diminution of delayed erythema and blocking of the reproduced eruptions almost only at the intradermal hydroxychloroquine site in five (SLE, one; DLE, two; and PMLE, two) out of seven positive uv-test reactors. The incidence of positive tests was higher in the antinuclear factor (ANF) tests (11.1%) suggesting a more active disease state in the ANF-positive PMLE patients. Antimalarial drugs may conceivably act by interfering with complement activity at the local tissue level in SLE, DLE, and PMLE or by DNA binding. (BBB)

19411 RADIOSENSITIVITY OF TESTES IN NEW-BORN MICE. Pomerantseva, M. D.; Ramaiya, L. K. Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 192-9(1965). (In Russian).

One-day old male mice were irradiated with x rays in doses of 20 to 800 R. The study of the degree of damage to the testes in animals aged 30 and 90 days showed that the testes of the newborn were more radiosensitive than in those of adults. The degree of difference increased as higher doses were applied and recovery was slower. (auth)

19412 THE CONDITION OF THE CARDIOVASCULAR, RESPIRATORY, AND NERVOUS SYSTEMS OF RATS TREATED WITH TRITIUM OXIDE. Veselovskaya, K. A.; Lyubimova-Gerasimova, R. M.; Zhuravlev, V. F. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 525-9(1967). (In Russian).

Tritium oxide was administered intraperitoneally to rats in doses of 0.3 and 0.08 mCi/gram of body weight. The arterial blood pressure increased rapidly; the pulse and respiration rates were practically unchanged. In the first four days after administration of a 0.3 dose the threshold and time of reflex reaction were reduced, indicating a brief change of the functional state of the nervous system; a subacute injury developed, with well-marked changes in the blood and the liver function. A 0.08 dose caused a mild injury. A dose of 1.1 mCi/g caused marked hypotonia which developed in 8 to 10 months. (JPRS)

19413 METHOD OF QUANTITATIVE EVALUATION OF THE EFFECT OF IRRADIATION AND OF CYTOSTATICS ON THE STRAIN CELLS OF BLOOD FORMATION IN MICE. Juraskova, V.; Tkadlecek, L.; Dostal, M. (Inst. of Biophysics, Brno). Cesk. Fysiol., 16: 149(Mar. 1967). (In Czech).

The effect of Endoxan (cyclophosphamide) on the blood-forming tissue in the pancreas of irradiated mice was investigated. Endoxan was applied in amounts of 30 to 135 mg/kg. Its effect was comparable to that of irradiation. D_0 equaled 69 mg/kg and 94 R. (JPRS)

19414 LEUKOCYTOSIS-INDUCING FACTOR IN THE BLOOD OF X-IRRADIATED RATS. Sodicoff, Marvin; Binhammer, Robert T. (Univ. of Cincinnati). Radiat. Res., 33: 82-93(1968).

Rats whose peripheral WBC counts had been lowered by 400 R of whole-body x irradiation served as donors of plasma that was injected intraperitoneally into recipient rats in 5-ml quantities under sterile and pyrogen-free conditions. Peripheral WBC and bone marrow data were obtained, and comparison was made with data obtained after injection of plasma from sham-irradiated donors. The effect of injection of plasma from irradiated donors was production of a leukocytosis caused by numerical increases of both neutrophils and lymphocytes. This leukocytosis was of greater magnitude than that resulting from injection of plasma from sham-irradiated donors. The more severe the leukopenia of the irradiated plasma donor, the greater was the capacity of the plasma to increase the peripheral white cell count of recipients; of the intervals tested, the effect was greatest at 4 days after irradiation. Quantitative analysis of the peripheral blood of recipients of plasma indicated that the resultant leukocytoses were due primarily to increases in the neutrophil population, regardless of the source of the plasma, and increases of lymphocytes in recipients of plasma from irradiated donors. Study of the bone marrow showed that there had been expulsion of granulocytes in recipients of plasma from irradiated donors, as contrasted with the lack of such an effect by plasma from sham-irradiated animals. Study of the peripheral blood and bone marrow was carried out on three recipients of multiple injections of plasma from irradiated donors. The results suggest that the plasma caused a hyperplasia of neutrophilic precursors following the expulsion of neutrophils. The results of the experiments suggest that depletion of circulating leukocytes following x-irradiation is accompanied by the appearance in the peripheral blood of a certain factor which acts to restore the normal numbers of circulating leukocytes. This factor acts at least in part by causing expulsion of stored neutrophils from the bone marrow and may in addition have some effect in increasing neutrophil production. (auth)

19415 EYE FINDINGS IN GOATS DURING THE 3 YEARS AFTER ACUTE WHOLE-BODY NEUTRON AND GAMMA IRRADIATION. Edmondson, P. W. (Medical Research Council, Harwell, Eng); Batchelor, A. L.; Lloyd, J. P. F. Int. J. Radiat. Biol., 13: 147-53(1967).

Goats which survived single whole-body exposure to γ and neutron irradiation in the lethal range were examined at intervals up to 3 years after exposure. Only 2 out of 28 goats receiving fission neutron radiation showed changes in the lens. No radiation-induced lens changes were found after gamma radiation. The low incidence of cataract was similar to that found in dogs and primates exposed to fission neutrons and in human survivors from atomic bombing. There was a systematic change according to body size in the sensitivity of the lens to neutrons. (auth)

19416 REPOPULATION OF PEYER'S PATCHES IN MICE. Evans, E. P. (Medical Research Council, Harwell, Eng.); Ogden, D. A.; Ford, C. E.; Micklem, H. S. Nature (London), 216: 36-8 (Oct. 7, 1967).

When irradiated mice were injected with bone marrow and lymphoid cells carrying distinct marker chromosome the pattern of cellular repopulation of the Peyer's patches resembled that of lymph nodes, not that of thymus. This supports the view that the patches are not the analogue of the avian bursa of Fabricius. (auth) (UK)

19417 RADIORESPONSE OF THE PRE-PUBERAL PORCINE OVARY. Erickson, B. H. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-gen-242. Int. J. Radiat. Biol., 13: 57-67 (1967).

The effects of γ radiation on the pre-puberal porcine ovary were studied following either whole-body or localized exposures. With whole-body irradiation, 115 gilts of mixed breeding were apportioned to age-groups of 20, 40, 80, and 100 days and dosage groups of either 200 or 350 R of ^{60}Co γ radiation (1.5 R/min). Ovaries of 19 miniature pigs of the Pitman–Moore strain, aged 30 to 50 days, were exteriorized and exposed locally to ^{137}Cs γ radiation in doses of 200 to 1000 R (27 R/min). At 30 days after irradiation, a super-follicular effect was induced by 200 R in ovaries of animals aged either 40 or 80 days at irradiation; but follicular growth was universally suppressed by 350 R. Numbers of primordial follicles were unaffected by 200 R, but a reduction of 26 per cent unrelated to age was induced by 350 R. In general, radiation reduced follicular quality, and in ovaries excised at 9 to 11 months after irradiation this continued as one of the principal evidences of a radiation effect. At slaughter, 11 of 32 gilts irradiated with 200 R, 16 to 41 gilts irradiated with 350 R, and 1 of 12 control gilts were not pregnant. Ovaries of the infertile animals were characterized by cystic corpora lutea. Data resulting from localized exposures established 500 R as the approximate LD_{50} for the primordial follicle of the pre-puberal pig. (auth)

19418 EFFECT OF SINGLE AND CONTINUOUS EXPOSURES OF GAMMA RADIATION ON THE SURVIVAL AND GROWTH OF THE BLUE CRAB, CALLINECTES SAPIDUS. Engel, David W. (Bureau of Commercial Fisheries, Beaufort, N. C.). Radiat. Res., 32: 685-91(1967).

The survival and growth of young blue crabs, Callinectes sapidus, were observed after single and continuous exposures to gamma radiation. In the single-exposure experiment, crabs were given doses of 4, 8, 16, 32, or 64×10^3 rads; crabs exposed to continuous irradiation received 3.2, 7.3, or 29.0 rads/hr. The $LD_{50(30)}$ value for the crabs receiving single exposures was estimated at 51,000 rads. Behavorial changes following irradiation, characterized by a loss of coordination, also appeared in these

crabs. The intensity of the behavioral change decreased with decreasing radiation dose. In the continuous-irradiation experiments, survival and growth were reduced only in the crabs exposed to the highest radiation dose rate of 29.0 rads/hr. Crabs receiving the lowest radiation dose rate of 3.2 rads/hr grew at a greater rate than crabs in the other two irradiated groups and in the control group. (auth)

19419 MODIFICATION OF HAIR DYSPLASIA CURVE BY RADIOPROTECTORS CONTAINING SULFUR AS A FUNCTION OF THE X-RAY DOSE. Beaumariage, M. L.; Van Caneghem, P. (Univ., Liege). Radiat. Res., 33: 74-81(1968).

X irradiation induces dysplasia of hair in the growing phase by two different mechanisms: the first and more radiosensitive can be greatly influenced by oxygen; the second, more radioresistant, is slightly or not sensitive to anoxia. Cystamine administered before irradiation by intraperitoneal injection acts on the hair bulb in two ways, for lower dose indirectly by anoxia and for stronger doses by its own mode of action. Cysteamine and, even more, cystamine injected after irradiation exercise a definite dysplasing action which enhances that of the x rays. (auth)

19420 MORTALITY OF THREE SPECIES OF DUCKS (ANAS DISCORS, A.CRECCA, AND A. CLYPEATA) EXPOSED TO IONIZING RADIATION. Tester, John R.; McKinney, Frank; Siniff, Donald B. (Univ. of Minnesota, Minneapolis). Contract AT(11-1)-1332. Radiat. Res., 33: 364-70(1968). (COO-1332-30).

Three species of wild ducks, held in captivity, were subjected to an acute whole-body dose of gamma irradiation to determine radiation sensitivity of adults. The $LD_{50(30)}$ as determined by probit analysis was 485 R for Anas crecca, 715 R for Anas discors, and 894 R for Anas clypeata. Birds dying during the first 24 hours after irradiation had extensive intestinal hemorrhages, whereas subsequent deaths appeared to be due to hematopoietic failure. (auth)

19421 CRITICAL FLICKER FREQUENCY IN ALBINO RATS FOLLOWING PRENATAL X-IRRADIATION. Sharp, Joseph C. (Walter Reed Army Inst. of Research, Washington, D. C.). Radiat. Res., 33: 22-9(1968).

Young adult rats that were exposed to 50, 100, 150, or 200 R of x rays on day 16 of gestation were compared to three types of control animals on a test of critical flicker frequency (CFF). It was found that CFF increased with increased dose. Differences between and within experimental and control groups are discussed. A hypothesis of why there was an increase rather than a decrease in the CFF following prenatal exposure to x rays was suggested. (auth)

19422 STUDY OF THE MITOTICALLY ACTIVE GERM CELLS OF THE GONADS OF X-IRRADIATED CHICK EMBRYOS. Udgaonkar, S. M.; Batra, B. K. (Indian Cancer Research Center, Bombay). Radiat. Res., 33: 337-47(1968).

Chick embryos were irradiated on day 4 and day 8 of incubation, and the germ cell population of the gonads was estimated with an analysis of their mitotic stages after intervals of 24 hours and five days. Irradiation is followed by an appreciable fall in the number of germ cells. The extent of this fall is independent of the age of the embryo at the time of treatment, and also of the interval between exposure and observation. The percentage of dividing cells increased within 24 hours after irradiation. Even after an interval of four days this increase in mitotic cells was persistent. The correlation between the radiosensitivity and the mitotic activity of germ cells is discussed, and it is suggested that the sensitivity of germ cells in division is independent of the influence of sex and age. (auth)

19423 LATE EFFECTS ON KIDNEYS IN WHOLE-BODY-IRRADIATED PARABIOSED RATS. Bjarnason, Olafur; Warren, Shields (New England Deaconess Hospital, Boston). Contract AT(30-1)-3777. Radiat. Res., 33: 357-63(1968).

Deac-Sionaker rats were parabiosed, and about three months later the right-hand animal received a single dose of 1000 R of 250-kV x radiation. The animals were observed for their entire life span. One hundred and eight pairs were chosen at random out of a much larger series, and late effects were studied on the kidneys only. Glomerulosclerosis of moderate to severe degree was found in 79.6% of the parabiosed irradiated rats, compared to 15.7% of the nonirradiated partners. Primary glomerulosclerosis was not observed in 12 pairs of parabiosed and 12 single control animals. Tubular lesions were also observed both in the irradiated and nonirradiated parabiont rats, but they were more pronounced in the former. Moderate to severe arteriolar thickening was found in more than one-half of the irradiated parabiont rats and in one-fifth of the nonirradiated. Pyelonephritis, arteritis, and inflammatory changes of glomeruli were more prevalent in the nonirradiated than in the irradiated parabiosed rats. Primary tumors of the kidneys were found in five parabiosed irradiated animals, which gives an incidence of 4.8%. (auth)

19424 THE RELATIONSHIP OF EXPOSURE RATE AND EXPOSURE TIME TO RADIATION INJURY IN SHEEP. Page, N. P.; Ainsworth, E. J.; Leong, G. F. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 33: 94-106(1968).

Radiation lethality in sheep was studied with ^{60}Co gamma radiation at five exposure rates ranging from 660 to 2.0 R/hr. The data show that a decrease in the exposure rate (or protracting the exposure over longer time periods) results in an increase in the LD_{50}. An analysis of these data shows linearity through the range 660 to 30 R/hr. However, between 30 and 3.6 R/hr, a sharp departure from this relationship occurs with the LD_{50}'s at 3.6 and 2.0 R/hr being considerably higher than would be predicted from extrapolation. In another series of experiments, the kinetics of injury accumulation at 2.6 R/hr was studied. The nature of the curve would indicate that the rate of injury accumulation is decreased as the total exposure and time of exposure are increased. The departure from linearity that occurs in both studies might suggest that at least two recovery processes are operative. Speculation is offered relating these results, and recovery mechanisms as described for cell-culture systems. The results are compared with expressions of dose-rate effectiveness derived for rodents and man. (auth)

19425 HEINZ BODY FORMATION AND CHRONIC RADIATION BURDENS: FURTHER INFORMATION. Gerhardt, P. (Univ., Tuebingen, Ger.). Fortschr. Geb. Roentgenstr. Nuklearmed., 107: 529-33(Oct. 1967). (In German).

Heinz body tests on erythrocytes were carried out in 123 nonirradiated and ninety-six irradiated patients. Persons exposed to irradiation professionally showed a significant increase in Heinz body formation with an average of twenty-five percent compared with eleven percent in non-irradiated persons. The results indicate that there is probably no threshold value for radiation effect. It follows that ionizing radiation reduces the resistance of hemoglobin in old erythrocytes to acetylphenylhydrazine. Probably the older cell population is affected by a reduction in glutathione content and enzyme activity. The hemoglobin in these cells is less well protected against ionizing radiation. (auth)

19426 QUANTITATIVE ASPECTS OF THE BIOCHEMICAL EFFECTS OF IRRADIATION. Marble, G. (CEN, Fontenay-aux-Roses, France). Radioprotection, 2: 55-72(1967). (In French).

Data published on the biochemical effects of irradiation on animals and man that show a quantitative relation between exposure and effect are reviewed and compiled. The effects observed enzymatic activity, blood picture, and urinary excretions are described. The biological effects of neutrons are briefly considered. 62 references. (J.S.R.)

19427 FUNCTIONAL COMPOSITION OF THE ADRENAL CORTEX AFTER IONIZING RADIATION. Graevskaya, B. M.; Shchedrina, R. N. Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 238-43(1965). (In Russian).

Total exposure of Kryukovskaya-population male mice with an x-ray dose of 600 R caused an increase in the weight and size of the adrenal glands and an accumulation of lipids in the adrenal cortex, mainly in the zona glomerulosa. A dose of 2000 R also resulted in a sharp increase in the lipid content in all three zones of the adrenal cortex. However, a distinct reduction in the weight and size of the glands was observed. It was suggested that the increase in the weight and size of the adrenal glands after an exposure to 600 R was connected with the accumulation of lipids and the excess of water in the gland. Corresponding changes after a dose of 2000 R were presumably explained by the exhaustion of the corticoid depot. (auth)

19428 AGE-DEPENDENT RADIOSENSITIVITY IN VARIOUS STRAINS OF MICE. Nechaev, I. A. Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 177-91(1965). (In Russian).

Radiosensitivity of mice of BALB/c, $C_{57}Bl$ and $CC_{57}Br$ strains at the age of one to 60 days was studied revealing differences in the level of radiosensitivity at various ages and the changing of death syndromes. It was found that radiation produced an inhibitory effect on the growth of mice exposed at the age of one day. Effects of different radiation doses on growth inhibition in animals of different genotypes were established. Significance of the genotypical (linear) and species factors of age-dependent radiosensitivity was discussed. (auth)

19429 INJURIES IN TESTES IN MICE IRRADIATED DURING EMBRYONIC DEVELOPMENT. Nuzhdin, N. I.; Kuznetsova, N. N. Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 147-61(1965). (In Russian).

The radiosensitivity of mouse testes during embryogenesis considerably exceeded the sensitivity of gonads in adult animals. Maximum damage to the testes was observed in animals which developed from embryos irradiated on the 16-th day of embryogenesis. The lowest x ray doses responsible for injuries in testes of animals irradiated in the period of embryonic development critical to the testes were 50 to 100 R. X ray doses of 200 and 400 R caused irreversible changes in mouse testes. The RBE of fast neutrons for testes during the period of embryonic development, as compared with x rays, was two to 2.5. The damage to testes with fractionated irradiation in the period of embryonic development critical to the testes was summed up. (auth)

19430 NEUROETHOLOGIC STUDIES ON CALOPTERYX SPLENDENS HARR. (ODONATA) AFTER X IRRADIATION OF THE CENTRAL NERVOUS SYSTEM. Buchholtz, Christiane (Univ., Marburg/Lahn, Ger.). Z. Zellforsch. Mikroskop. Anat., 82: 282-306(Sept. 22, 1967). (In German).

After x irradiation of the supraesophageal ganglia of Calopteryx larvae three phases could be distinguished that were characterized by ethological features: an early defect period, latent period, and late defect period. The duration of the early defect period was independent of the age of the animals as well as the dose, while the latent period that was free of radioinduced disorders was dependent on both. The time of latency may be used as a measure of sensitivity to x rays. In accordance with the ethologically defined phases, morphogenetic and, in particular, regeneration processes were studied by electron microscopy. Examination included 4 perikaryon types of the protocerebrum, and the protocerebral neuropile with its interneural synapses was also investigated. The perikaryons were able to repair structural damage to a high degree. A characteristic morphogenetic sequence was found for distinct cell organelles, showing that during the early defect period, and even more so during the time of latency, structural changes occurred. In this respect the different states of the mitochondria were informative. The organelles were rearranged during the late defect period, reaching an arrangement that was nearly normal. Damage to the globuli perikaryona which were not grouped together was irreversible. In contrast to the high regenerating capacity of the perikaryons, the neuropile did not recover by the time late defects were manifested. It was not capable of transmitting excitations at this time, as judged by morphologic criteria. It could not be determined whether fibers and their synapses are able to regenerate after the restitution of the perikaryons. Morphogenetic investigations indicated that the restitution of the structural elements of the perikaryons and that of the neuropile under given conditions were separated by so great an interval that regeneration of the fibers could not directly follow regeneration of the perikaryons. (BBB)

19431 DISPOSITION OF PREGNANCIES INCIDENT TO CANCER OF THE CERVIX. Liu, Shu-hsiang; Teng, Wen-man; Ts'ai, Shu-mo (Shanghai First Medical Coll.). Chung Hua Fu Ch'an K'o Tsa Chih, 11: 102-6(Mar. 1965). (In Chinese).

The disposition of 75 cases where treatment of cervical cancer was complicated by pregnancy was analyzed. Factors that govern determination of prognoses in such cases are listed. Relationships between stage of pregnancies and stages of cancer are explored in detail. Effects of irradiation on the fetus are discussed, with particular emphasis on baldness in the child. It was concluded that effects depend upon dosage, age of fetus and range of irradiation. (JPRS)

19432 TECHNIQUE FOR LABELING SERPENTS WITH RADIOISOTOPES. Naulleau, Georges (Faculte des Sciences, Nancy). Compt. Rend., Ser. D, 265: 1976-9(Dec. 18, 1967). (In French).

A technique is described for labeling serpents in such a way that the ^{60}Co wire does not come into contact with the body of the animal. It is introduced inside of a cylinder of colored plastic in a sleeve that serves for labeling. The effect of the radioisotope on the body of the serpent is minimized and probability of survival is increased. The risk of loss of the radioisotope is equally eliminated. (tr-auth)

19433 EVIDENCE OF RADIORESISTANCE OF GERM CELLS IN LEPTINOTARSA DECEMLINEATA (COLEOPTERA). Bluzat, Roger (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. D, 265: 2027-9(Dec. 18, 1967). (In French).

The posterior extremities of eggs of the insects were exposed to x radiation before attaining the stage of 16 nuclei. Histological sections of larvae from irradiated eggs were prepared for examination of the gonads. A second group of irradiated eggs was reared to adults and the gonads were examined. Adults developing from eggs exposed to a dose of 10^6 R were fertile and reproduced normally; this demonstrates the extreme radioresistance of the germ cells. Larvae developing from eggs exposed to 10^7 R contained gonads without gametes. This result was not caused by selective destruction of the germinal primordia located in the posterior region of the egg. (H.L.W.)

19434 NEUROHUMORAL MECHANISM OF THE REMOTE ACTION OF IONIZING RADIATION. Domareva, O. P. Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 244-52(1965). (In Russian).

The remote effect of x rays (at a dose of 600 R) was determined by the changes in mitotic activity of corneal epithelium in mice irradiated with their heads shielded. It was shown that the administration of neurotropic substances (redergam and hexonium) to animals before irradiation changed the remote effect. At the same time the administration of hexonium affected the histological structure of suprarenal glands and the humoral composition of the blood in the exposed animals. It was concluded that the remote effect had a neurohumoral nature. (auth)

19435 EFFECTS OF LOW DOSES OF IONIZING RADIATION ON MULTIPLICATION OF PARAMECIUM AURELIA. Planel, Hubert; Bru, Andre; Soleilhavoup, Jean-Pierre; Tixador, Rene (Faculte de Medecine, Toulouse). Compt. Rend., Ser. D, 264: 2945-8(June 19, 1967). (In French).

Cultures of Paramecium aurelia were exposed to γ radiation from ^{60}Co sources having activities of 0.139, 1.78, and 8.7 μCi. The intensity of exposure was 600 mR for the first group, 8000 mR for the second group, and 39000 mR for the third group. The irradiated and control cultures were kept at a temperature of 27°. The time of exposure varied from 51 to 91 hr. The results can be divided into two groups. Before 65 hours of exposure, the effects of radiation were very slight. There was no definite relation between dose and effects on the organisms. After 65 hours of exposure, radiation produced a constant acceleration in the growth of organisms, and a definite correlation between dose and effects on the organisms was observed. (H.L.W.)

19436 EFFECTS OF X RAYS ON SEROTONIN LEVELS IN BLOOD OF MICE. II. PROTECTION BY SHIELDING THE EXTERIORIZED SPLEEN. Momma, H.; Nakamura, W.; Arakawa, S.; Eto, H. (Institut National des Sciences Radiobiologiques, Chiba, Japan. Institut des Maladies Infectieuses, Tokyo). Compt. Rend. Soc. Biol., 161: 1177-80(1967). (In French).

In mice with exteriorized, shielded spleens, the decrease of the serotonin content in the blood and of the numbers of platelets caused by 600 R of x radiation was comparable to that caused by 100 to 200 R in mice with intact, unshielded spleens. (tr-auth)

19437 STUDY ON THE LEUCOCYTE-REDUCING SUBSTANCE IN A RADIATION INJURY. Hara, Hutaka (Tohoku Univ., Sendai). Nippon Sanka Fujinka Gakkai Zasshi, 19: 144-52(Feb. 1967). (In Japanese).

Studies were made on the injuries caused by deep radiotherapy to cancers of the uterus. The etiological factor that induced injury following radiation therapy was found to be in the blood cells and not in the serum. This factor was extracted and named Radiotoxin. The method of Radiotoxin extraction and its nature were studied. It was discovered that a substance, acting on the central nervous system, and thus reducing the count of leukocytes, exists also in normal blood cells. Radiotoxin, obtained by treating the liquid from the dialysis of blood cells of irradiated leukopenic rabbits, with alcohol, acetone, and ether had a marked effect in reducing the count of leukocytes, and hence induced injuries to the hematopoietic tissues. The same substance from a normal rabbit also had a leukopenic effect. Compared to Radiotoxin, it was somewhat unstable to heat, but caused no injuries to the tissues. The initial leukopenic effect of Radiotoxin was completely inhibited by administration of acetylpromazine. This indicated that the reduction in the count of leukocytes, in the early stage of radiation injury may be caused by the malfunctioning of the leukocyte-adjusting function of the central nervous system. The fluctuation in the leukocyte count of peripheral blood was gradually reduced following the continuous administration of Radiotoxin, but the injury to organs was increased. This shows the direct effect of Radiotoxin for the induction of leukopenia in the last stage of radiation injury. (NSA of Japan) (TSS)

19438 RADIOSENSITIVITY OF PERIPHERAL BLOOD ELEMENTS IN VIVO AND IN VITRO IN DIFFERENT ANIMAL SPECIES. Nuzhdin, N. I.; Kuznetsova, N. N. Tr. Inst. Genet., Akad. Nauk SSSR., No. 32, 136-46(1965). (In Russian).

It was shown that the number of leukocytes in peripheral blood under normal conditions could be used to determine the radioresistance of mice. No relation between the initial red blood picture and animal radioresistance was established. Using luminescent microscopy, differences were revealed in the radiosensitivity of lymphocytes of peripheral blood in vitro in animals of various

species and man. The investigation of the radiosensitivity of lymphocytes in vitro in different animal species and in man permitted the following order of declining radiosensitivity to be established: rabbit, man, rat, mouse, guinea pig. (auth)

19439 IONIZING RADIATION AND EXTRACTION OF THYMUS AS THE FACTORS ENHANCING THE CHEMICAL CARCINOGENESIS IN THE MOUSE SKIN. Schneiberg, Krzysztof; Gorski, Tadeusz. Nowotwory, 17: 325-31(Oct.-Dec. 1967). (In Polish).

The results of investigations made on 102 mice indicate that whole-body irradiation with 500 R of x rays of animals thymectomized at the age of three months, potentiates the occurrence of epidermoid carcinomas after serial spraying with methylcholanthrene. Neither irradiation alone nor extraction of the thymus enhanced chemical carcinogenesis in the animals examined. Most probably one of the important factors affecting the neoplastic process is the age of animals at thymectomy. (auth)

19440 FISTULAS AND POST-IRRADIATION LESIONS IN LUNGS AS COMPLICATIONS RESULTING FROM THE USE ROTATING ROENTGENOTHERAPY IN PATIENTS WITH ESOPHAGUS CARCINOMA. Uleniecka, Urszula. Nowotwory, 17: 339-44(Oct.-Dec. 1967). (In Polish).

Frequency of complications occurring in 138 patients treated with x rays using the rotating method during 1958 to 1964 is analyzed in the present paper. The fistulas and post-irradiation changes were observed in 10 and 40 percent of cases, respectively. The fistulas occur during roentgenotherapy and after its completion. The pulmonary post-irradiation changes are most frequently observed after doses 2000 to 4000 R per lung tissue. (auth)

19441 EFFECT OF REPEATED LOW-DOSE X-RAY IRRADIATION OF PREGNANT MICE ON THE DEVELOPMENT OF THE TESTIS IN THEIR OFFSPRING. Pilyavskaya, S. M. (Kiev Medical Inst.). Nauch. Dokl. Vyssh. Shk., Biol. Nauki, No. 7, 60-3(1967). (In Russian).

Pregnant mice received a daily dose of 6, 12 or 24 R for a total of 48 to 360 R at 6 R/min for a certain period of/or throughout their pregnancy. A total of 67 mice were irradiated, of which 61% bore young as against 83% in controls. The 98 males from the test offspring and 37 of the control group were sacrificed 1, 7, 22, 35 or 42 days after birth, and the prepared testis specimens were evaluated according to standards developed for each stage: the number of gonocytes, their distribution, and mitosis for the earlier stages; weight, average width of seminal canals, serial cells in their walls, and spermatogenic elements for the later stages. Behavior and development were also observed. Size of litters and sex ratio were the same in both animal groups. Weight of the newborn test animals was just about the lower limit for normal, and growth and development were normal; however, they had less vitality, and many died in the first month after birth. No sex difference was observed for mortality. It was found that testicular development in the offspring depended not only on the total dose but also on the daily dose and the embryogenetic period during which it was received. Such development was normal only when a daily 6 R dose was given in the first 9 days; if that same dose was given throughout pregnancy, postembryonal development slowed down after a few days and the slow-down was still present after 35 to 42 days. No pathology was observed. At a daily dose of 12 or 24 R (total 108 R or more), abnormal development started during embryogenesis and continued later. Daily 6 R doses throughout pregnancy (108 R) slowed testicular development without affecting the number of spermatogenic cells. Later-stage irradiation with a 12 R dose (48 to 192 R) caused a considerable decrease in the number of spermatogenic cells. An increase of the dose to 24 R (120 to 360 R total) caused absence of spermatogenic cells in the majority of the seminal canals. Irradiation in the second half of pregnancy at the time the glands were formed had a greater effect on testicular development in the offspring compared to that in the first half. Here a total dose of 43 R (12 R daily for 4 successive days) caused greater damage than a 96 R dose (12 R daily) during the first 8 days or a 108 dose (6 R daily) throughout pregnancy. A total dose of 120 R on the last 5 days before birth caused greater changes than a 192 R dose received in 16 sessions. It was thus concluded that data on total radiation dose without indication of irradiation periods and size of the single dose were inadequate for evaluating their effect on the offspring. (ATD)

19442 COMPARATIVE EFFECT OF VARIOUS ISOTOPES ON THE PERIPHERAL BLOOD. Tsygankova, Yu. I.; Yakovleva, N. G. (Scientific Research Inst. of Radiation Hygiene, Leningrad). Radiobiologiya, 7: 587-90(1967). (In Russian).

Strontium-90 and ^{144}Ce were administered to three groups of rats for 180 days. Group I received ^{90}Sr at a concentration of 0.08 μCi (by the end of the experiment the absorbed dose was 165 rads to the skeleton and 21.6 rads to the gastrointestinal tract; Group II: 0.008 μCi (23.8 and 2.16 rads respectively); Group III: 1.6 μCi ^{144}Ce (16.7 and 468 rads respectively). No changes in the peripheral blood characteristic of chronic radiation sickness were found in the animals of any group. Changes in leukocytes, neutrophils and thrombocytes had a phase character. The observed deviations were most evident in the animals of groups I and III, expressed as qualitative changes of the leukocytes. (JPRS)

19443 ON THE CONSERVATIVE TREATMENT OF RETINOBLASTOMA. Leuenberger, A. (Univ., Basel). Ophthalmologia, 152: 242-6(1966). (In German).

According to current practice the proper dose to use for treatment of retinoblastomas is between 3000 and 4000 R. The upper limits of this range are associated with frequent appearance of complications. Ultrahard (^{60}Co) γ radiation was used to treat retinoblastoma in two series of irradiations. In 6 treatments 3600 R were administered, and 1 yr later 2500 R were administered in 10 treatments. This treatment did not effect a cure. A similar lack of positive results was obtained in another case after administration of 5700 R given in 3 series of treatments. Although it has been reported that supplemental treatment with cytostatics increases the prospects for success with irradiation treatment of retinoblastomas, it was concluded that it is not advisable to use combined irradiation and cytostatic treatment in infants because of the danger of brain damage. If irradiation is given after retinal photocoagulation, the impaired blood supply may reduce the effectivity of the irradiation. (BBB)

19444 A CORRECTIVE OPERATION FOR STRICTURE OF THE RECTUM: REPORT OF A CASE. Silvennoinen, Ensio; Asp, Kari (Univ. of Helsinki). Acta Chir. Scand., 132: 597-600(Nov. 1966).

Successful surgery in a 63-yr-old woman who had been given x-ray treatment for uterine cancer, resulting in rectosigmoid stricture, is described. Because of chronic obstruction, sigmoidostomy was carried out. Later examination of the colon revealed that the sigmoid had shrunk throughout its length to the form of a ribbon and that there was almost complete obstruction at the rectosigmoid border. Since the rectum, however, seemed normal, an attempt at reconstruction of the passage was considered. The intestine was surrounded by firm scar tissue so that end-to-end anastomosis was impossible. It was therefore decided to carry out implantation anastomosis end-to-side, since a pull-through operation was not possible. About 20 cm of the narrowed sigmoid was resected, and after the colostomy had been closed the upper portion of the colon was mobilized. A longitudinal opening about 2 in. long was made in the anterior wall of the ampulla recti, into which about 4 to 5 cm of the end of the colon was introduced. The serosa of the implanted intestine was sutured to the wall of the rectum. To support the anastomosis, a thick rubber tube was inserted and transversostomy was also carried out. One month later the transversostomy was closed. The intestinal passage functioned perfectly and colography showed satisfactory filling of the rectum and sigmoid. (BBB) (TSS)

19445 EFFECT OF IONIZING RADIATION ON THE BONE SYSTEM OF THE FETUS AND ON THE BLOOD SERUM PROTEIN FRACTION IN PREVIOUSLY THYROIDECTOMIZED AND IRRADIATED ANIMALS. Adamyan, T. V. Biol. Zh. Arm., 20: No. 7, 20-24(1967). (In Russian).

The effect of thyroidectomy on the protein fraction of animal blood serum and on the bone system of the fetus of irradiated animals was studied. Adult female white rats were thyroidectomized and irradiated daily throughout pregnancy with Co-60 gamma rays or with x rays (1 R per day, maximum of 60 R). There was little change in the total protein content (4.2 to 6.7%) of the blood serum before and after the thyroidectomy. The albumin-globulin coefficient started to change, increasing from an initial value of 1.2, that remained steady until 23 days after the operation, to 1.8 68 days after the operation. The albumin content started to increase somewhat, while the total globulin level decreased, alpha globulin increases slightly, beta globulin decreased by 12%, and gamma globulin decreased substantially, by 42%. Thyroidectomy itself had almost no effect on the bone system of the fetus, but chronic irradiation of pregnant females with either gamma rays or x rays caused changes in the bone system of newborn rats. There was little deformation of the skull, but there was some change in contour and slight curvature of the neck and spine. (ATD)

19446 POLYMORPHOUS LIGHT ERUPTION: OFFICE DIAGNOSIS AND TREATMENT. Harber, Leonard C.; Holloway, Ronald M.; Moragne, Mary E. (New York Univ., N. Y.). N. Y. State J. Med., 64: 619-23(Mar. 1, 1964).

A uv light source was used to reproduce the clinical lesions of

polymorphous light eruption. The lesions that were induced by uv irradiation of the uninvolved skin of 16 patients with polymorphous light eruption were found to be clinically similar to those resulting from exposure to natural sunlight. Fluorescent sunlamp tubes were used in this study; the major portion of the emission spectrum of this source is between 2850 and 3300 Å. Controlled studies for comparative purposes were performed using natural sunlight, a carbon arc lamp, and a hot quartz mercury vapor lamp. Sites, 2.5 by 2.5 cm, on the lower lumbar area were irradiated at a target skin distance of 25 cm. The intensity of the uv radiation reaching the skin site at this distance was 1000 $\mu w/cm^2$. The exposure ranged from 30 to 360 sec or an erythema dose of 0.5 to 6 units. This corresponded clinically with 10 to 120 min of New York City sunlight at noon in June. The dosage of uv radiation necessary to induce lesions averaged 1.5 by 10^6 erg/cm^2. These studies confirmed that uv light was the responsible factor in polymorphous light eruption. Elimination of this radiation by means of a window glass filter (removing uv radiation below 3150 Å) abolished the capacity to induce the lesions. However, two unusual cases diagnosed as erythema solare perstans did develop abnormal erythema through the window glass filter. Patients with chronic discoid lupus erythematosus and normal volunteers showed no abnormal response. The same light source and technique were used for demonstrating the beneficial effects of topical sunscreens and internal quinoline therapy in treatment of polymorphous light eruption. (BBB)

19447 BLOOD PROPERTIES OF PATIENTS OF UTERINE CERVIX CANCER TREATED BY THE RADIOTHERAPY AND HEALED. Suzuki, Masahiko; Sasagawa, Shigeo (Niigata Univ., Japan). Nippon Sanka Fujinka Gakkai Zasshi, 18: 647-52 (July 1966). (In Japanese).

The blood properties of 42 cases of uterine cervix cancer who received radiotherapy (mainly by x rays) and are still alive (July 1960) for 5 to 20 years after treatment were studied. Blood properties at the time of admission, at the end of irradiation, and at present were compared. Leukocyte counts were made at the time of first admission of 1223 of the patients. The mean values of hemoglobin and the erythrocyte count before irradiation, at the end of irradiation, and at present are 75% and 350×10^4, 76% and 362×10^4, and 70% and 340×10^4, respectively, and among these no significant difference was observed. The mean value of leukocyte count before irradiation, at the end of irradiation, and at present are 7000, 5300, and 4700, respectively. The leukocyte count rapidly decreased from that before irradiation, and it is further slightly decreased at present from that immediately after irradiation. This leukopenia tends to become more severe with the lapse of years after irradiation. In the white blood picture, both neutrophil leukocytes and lymphocytes were decreased at the end of irradiation; and at present the number of lymphocytes is restored to normal and that of neutrophil leukocytes remains decreased. The one-hour and two-hour values of the erythrocyte sedimentation rate before irradiation, at the end of irradiation, and at present are 28 mm and 53 mm, 31 mm and 55 mm, and 19 mm and 43 mm, respectively. There was no significant difference before and after irradiation, and at present it is considerably improved. The mean value of the leukocyte count of patients with uterine cervix cancer at the first admission was about 7000, then gradually decreased, and remained at about 6000. (NSA of Japan) (TSS)

19448 THYROID ABNORMALITIES AFTER RADIATION EXPOSURE IN INFANCY. Pincus, Ralph A.; Reichlin, Seymour; Hempelmann, L. H. (Univ. of Rochester, N. Y.). Ann. Intern. Med., 66: 1154-64 (June 1967).

A long-term mail survey of 2278 persons treated with x rays in infancy for thymic enlargements revealed an increased prevalence of thyroid neoplasms during adolescence and young adulthood. One subgroup of 268 individuals, treated with the same x-ray technique, accounted for 20 of the 41 thyroid neoplasms in the entire irradiated population. Since thyroid neoplasma usually develop insidiously and may not be apparent to the subject, 105 individuals were examined to determine the true prevalence of thyroid nodularity. Twenty-five of these persons, now between 17 and 37 yr of age, had abnormal thyroid glands to palpation; 23 were nodular and 2, diffusely enlarged. For comparison, 113 persons without a history of irradiation but matched for age, sex, and residence revealed only 5 abnormal glands, 2 of which were nodular. Not only was the frequency of thyroid nodularity much greater in the irradiated group, but the lesions were much more extensive. On reexamination of 44 subjects 1 to 3 yr later, 6 new nodular lesions in previously normal glands were detected, and 2 abnormal glands had regressed without treatment. A statistically significant increasing prevalence of thyroid nodularity with increasing x-ray dose was noted but no demonstrable increase with age within the subgroup. The risk of developing thyroid nodularity after exposure in infancy to x ray doses to the thyroid in this range (mean dose in air, 353 R with extremes of 130 and 1070) was estimated to be almost 30% or about 1 in 3 for this age group. Previously, the risk of developing thyroid carcinoma after this type of exposure was found to be about $\frac{1}{10}$ of this, or 4.3%. (BBB)

19449 NEW EXPERIMENTAL ANIMAL STUDIES ON THE PROBLEM OF THE RADIOSENSITIVITY OF THE URETER. Castano, A.; Almendral, Y.; Frischkorn, R. (Univ., Goettingen, Ger.). Arch. Gynaekol., 204: 52-3 (1967). (In German).

Effects of 200 kV x rays and ^{60}Co γ irradiation on the ureters were compared in rabbits. The irradiation doses were 1500, 3000, or 6000 R. Histological, histochemical, and histometric studies of the ureteral sections irradiated most directly, performed at 1, 2, 4, 7, or 9 weeks after irradiation, showed few macroscopic injuries of the efferent ureters. Lesions of various severities were observed in about 17% of the animals. Ureters irradiated with 1500 R appeared normal within four weeks after irradiation. The rabbit ureter appeared to be relatively insensitive to radiation. The lack of early changes did not exclude the possibility of late changes taking place after a period of latency. However, studies conducted with still higher doses of irradiation with follow-up periods extending to 30 weeks after irradiation confirmed that the sensitivity of the rabbit ureter to x irradiation was rather low. (BBB)

19450 INTRAUTERINE FETAL TRANSFUSION WITH TELEVISION FLUOROSCOPIC CONTROL. Whitehouse, Walter M.; Griewski, Lawrence R.; Jaffe, Robert B.; Work, Bruce A.; Campbell, Colin (Univ. of Michigan, Ann Arbor). Radiol. Clin. N. Amer., 5: 67-72 (Apr. 1967).

Radiation hazards to the fetus during fluoroscope-monitored transfusion in the treatment of erythroblastosis fetalis were evaluated. Image-intensified television fluoroscopy can be used effectively to determine fetal position, to select the optimum site for needle puncture, to control the advance of the needle into the fetal peritoneal cavity, and to confirm its location by injection of contrast material. With increasing experience during these procedures, there has been a significant reduction in the exposure time needed. The entire procedure frequently takes about 30 min and the actual fluoroscopy is about 1 to 2 min in duration, much of it with a small field encompassing only the needle tip and adjacent fetal landmarks. It is difficult to assess precisely the radiation dose delivered to the fetus because of the many variables involved: size and age of the fetus, size of the uterus and quantity of amniotic fluid, thickness of the maternal abdominal wall, position of the fetus, and time needed to achieve satisfactory placement of the needle and catheter. In measurements made with a phantom and ionization chamber and using a television system, the maximum dose rate to the fetus of 76 mR/min for an average of 3 min fluoroscopic time, the calculated dose was 228 mR. Measurements during x-ray filming indicated a fetal dose of 155 mR per pair of frontal and lateral films when all precautions were taken to reduce radiation. In fetal transfusion methods using x-ray films alone, several pairs of films are needed. Therefore, in most cases the television fluoroscopic method involves less radiation exposure of the fetus. In view of the otherwise serious prognosis, it is concluded that this relatively small radiation hazard is justified. (BBB)

19451 CHROMOSOME ANOMALIES AFTER IRRADIATION WITH SMALL DOSES OF GAMMA RAYS. Caratzali, A.; Stefanescu, D. T.; Popescu, H.-I. (Inst. of Legal Medicine and Clinic of Occupational Diseases, Bucharest). Presse Med., 75: 1637-8 (July 1, 1967). (In French).

In 3 young industrial technicians accidentally irradiated with small doses (3 to 26 rad) of γ rays emitted by a radioiridium source of 6034 Ci, peripheral blood cultures taken on 5 occasions at varying intervals up to 5 months after the accident exhibited chromosome anomalies (chromosome and chromatid exchanges, fragments, dicentric and ring chromosomes) with no other accompanying symptomatology. Three days after the exposure the total percentage of chromosome anomalies in the cultured leukocytes in the 3 subjects was 35.0, 31.5, and 41.3%. Interchanges were the most frequent anomalies, being found in about 20 to 25% of the cells examined. Ring chromosomes were found in only 3 instances, among about 500 cells examined. It was not possible to assess the dose-effect relation, but the subject receiving the largest radiation dose (12 rad to the sternum and 26 rad to the gonads) exhibited a higher frequency of chromosome anomalies than the other 2 who received $\frac{1}{4}$ to $\frac{1}{8}$ as large doses. These findings show that chromosome anomalies revealed in cell cultures may constitute the sole indication of excessive irradiation and that the harmful dose of ionizing radiation for man is extremely low, probably less than 1 rad. Thus the greatest care

should be taken by the physician when ordering or performing x-ray examinations. (BBB)

19452 HISTOLOGICAL FACTORS IN THE RADIOTHERAPY OF TUMORS. Glucksmann, A. (Strangeways Research Lab., Cambridge, Eng.). pp 72-88 of The Treatment of Cancer, With Special Reference to Radiotherapy and Chemotherapy. Mitchell, J. S. (ed.). Cambridge, Eng., University Press, 1965.

Radiosensitivity of tumors as correlated with histologic type is reviewed. Attempts to correlate radiosensitivity with various measures of the maturity of tumor types have yielded inconclusive results, and no clear evidence has been presented that anaplastic tumors of the same site and clinical extent respond better to radiotherapy than differentiated types. Equal cure rates may be found in the 3 main categories of the radiosensitivity tables among radiosensitive, moderately radiosensitive, and radioresistant tumors. The speed of changes in volume of a tumor is not a measure of its radiosensitivity or radiocurability. Differentiated tumors tend to be more radiocurable than anaplastic cancers of the same site and clinical extent, because they have fewer reproductive cells and more stroma and are more frequently capable of responding to radiation by increased differentiation in addition to the death of reproductive cells. Failure of a radiotherapeutic cure of a patient is frequently associated with the persistence of the carcinoma at the primary site. The type of the tumor is influenced by systemic conditions in the host. Systemic factors as well as the tumor and its type influence the response to irradiation of both normal host tissues and the carcinoma. Patients with refractory tumors can be selected for alternative or additional treatments by histological and cytological tests. (BBB)

19453 POSTIRRADIATION MESENCHYMAL CHONDROSARCOMA: A CASE REPORT. Sears, William P.; Tefft, Melvin; Cohen, Jonathan (Children's Hospital Medical Center, Boston). Pediatrics, 40: 254-8(Aug. 1967).

The case reported is that of an unusual variety of chondrosarcoma of the vertebrae (mesenchymal chondrosarcoma). It developed in a 12-yr-old girl following radiation therapy for an intra-abdominal malignancy. Postoperatively, for a Wilms's tumor 200-KV x ray therapy was administered to the residual tumor tissue. The entire tumor bed, including most of the right abdomen, was irradiated through opposed anterior and posterior portals, 15 by 10 cm. All bony elements of the thoracolumbar spine from T-9 to L-4 were included in the irradiation field and a dose of 3360 rad was delivered in 23 days. For 12 yr the patient enjoyed good health, then developed progressive lumbar pain and paraparesis. An extensive, avascular, firm tumor involving the spinous processes of T-10 to L-1 and invading the local musculature was found at surgery. A review of the literature disclosed 24 cases of postirradiation bone sarcomas in children, 3 of which were chondrosarcomas. The mesenchymal type of postirradiation chondrosarcoma has not been previously described. It is emphasized that the therapeutic benefit of radiotherapy to malignant tumors far outweighs the risk of late postirradiation malignant change. Of the 207 cases previously reported, only 2 developed subsequent bone sarcomas. In the great majority of postirradiation bone sarcomas reported in the literature, the dose was in excess of 3000 R. (BBB)

19454 EFFECT OF FOLIC ACID ON PHOSPHOPROTEIN METABOLISM OF THE BRAIN NORMALLY AND DURING ACUTE RADIATION SICKNESS. Sopin, E. F.; Kucherenko, M. E. (Kiev State Univ.). Ukr. Biokhim. Zh., 39: 269-75 (1967). (In Russian).

Recent studies showed that the phosphorus of phosphoproteins was metabolized more rapidly than that of nucleic acids and lipids, indicating that it performed other important functions. Hence phosphoprotein metabolism of the brain during acute radiation sickness, and the effect of folic acid, a radioresistive compound, on this metabolism was undertaken. Guinea pigs were exposed to a total x-radiation dose of 2000 R and injected with folic acid. The rate of phosphoprotein metabolism was determined as a function of the rate of incorporation of radioactive phosphorus. Following irradiation, the phosphoprotein content of the guinea-pig brain decreased, while the rate of phosphoprotein metabolism increased. Folic acid normalized the phosphoprotein content of the brain and stabilized phosphoprotein metabolism during acute radiation sickness. Prolonged administration of folic acid to healthy controls resulted ultimately in some increase in the rate of phosphoprotein metabolism and decrease in the rate of metabolism of inorganic phosphorus. Irradiated guinea pigs injected with folic acid (1 mg of sodium salt solution of folic acid per 100 g body weight) survived for eight to eleven days, whereas irradiated guinea pigs receiving no folic acid died five or six days following irradiation. (JPRS)

19455 SACCHARIN AVERSION BY RATS AFTER TREATMENT WITH PROFERRIN AND X-IRRADIATION. Feinberg, Allen Mark. Gainesville, Fla., Florida State Univ., 1966. 39p.

Thesis.

Rats' preferences between a saccharin solution and tap water were measured at intervals of 1, 2, 6, 24, 48, 72, and 96 hours following treatments with 68 R x radiation, Proferrin, or both Proferrin and x radiation. The Saccharin Preference Test was initiated at 0, 12, or 24 hours following the Proferrin or x radiation treatments. Both Proferrin and x irradiation were observed to lead to avoidance of the saccharin solution. When animals were treated with both Proferrin and x irradiation there was greater saccharin avoidance than when the animals received only one of these treatments. Increasing the intervals between the treatments and the Saccharin Preference Test diminished the saccharin avoidance effect. These results were said to support the hypothesis that Proferrin and x irradiation effected saccharin preference in a similar manner. It was suggested that this lends support to the thesis that x irradiation, in addition to Proferrin, modifies the activity of the reticuloendothelial system. (Disser. Abstr.)

Radiation Effects on Plants

Refer also to abstracts 19253, 19268, 19293, 19294, 19307, 19312, 19313, 19320–19322, 19359, and 19397.

19456 THE RELATIVE BIOLOGICAL EFFICIENCY OF GAMMA RAYS AND FISSION NEUTRONS IN PLANT SPECIES WITH DIFFERENT NUCLEAR AND CHROMOSOME VOLUMES. Donini, B.; Sparrow, A. H.; Schairer, L. A.; Sparrow, Rhoda C. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-gen-16. Radiat. Res., 32: 692-705(1967). (BNL–11049).

Young seedlings of five plant species (Vicia faba, Pisum sativum, Helianthus annuus, Raphanus sativus, Arabidopsis thaliana) with widely different nuclear and interphase chromosome volumes (ICV) were acutely irradiated with various doses of ^{60}Co gamma rays and fission neutrons. Meristematic shoot apices of control plants were fixed at the time of irradiation, and interphase nuclear and chromosome volumes were calculated from measurements of nuclear diameters. The relation between nuclear or chromosome volume and radiosensitivity as well as the possible influence of differences in these volumes of RBE was studied. Radiation injury was evaluated on the basis of plant survival, plant dry weight, plant height, and pollen abortion. Dose-effect curves were obtained from the two kinds of radiations; the doses necessary to produce a 50% effect were calculated for each species and each end point used. The doses required for a 50% effect were highest for survival, lowest (and about the same) for dry weight and height, and intermediate for pollen abortion. The 50% doses increase for gamma rays and for fission neutrons with decreasing nuclear or chromosome volume characteristic of the species; for example, the LD_{50} for gamma rays varied from 420 to 30,297 rads and that for neutrons from 91 to 6558 rads for Vicia and Arabidopsis, respectively. The RBE values calculated at the 50% effect are about the same for the same biological end point in each of the different species in spite of the large differences in the nuclear or chromosome volumes. Individual RBE's for all species and all end points varied from about 4 to 8.4. The average RBE for all species at any one end point varied from 5.0 for LD_{50} to 6.7 for 50% growth inhibition (dry weight). It is concluded that nuclear and chromosome volumes are as important for determining relative radiosensitivity to densely ionizing radiation as for sparsely ionizing radiation and that variation in these nuclear parameters does not influence RBE in a consistent or predictable manner. (auth)

19457 EFFECTS OF ULTRAVIOLET AND X RAY RADIATION ON IN VITRO CULTIVATED CELLS OF HAPLOPAPPUS GRACILIS. Eriksson, Tage (Univ. of Uppsala). Physiol. Plant., 20: 507-18(1967).

Cell suspensions of H. gracilis were subjected to uv (2537 Å) and x irradiation. Mitotic inhibition and killing were studied after uv exposure. The survival curve of uv-treated cells showed the LD_{50} to be about 2000 erg/mm^2 under the experimental conditions used. All types of chromosome aberrations were induced by uv irradiation, but their frequency was relatively low at doses that did not completely inhibit cell division. A mutant strain was isolated after uv treatment. Mitotic inhibition and killing were also studied after x-ray treatment. The survival curve showed the LD_{50} under the culture conditions used to be about 2000 R. The frequency of chromosome aberrations induced by x rays was markedly increased by aeration during x-ray treatment, indicating that some degree of cell anoxia existed in cell suspensions. Chromo-

some aberrations did not seem to cause growth inhibition to an extent usually considered to occur. (BBB)

Radiation Effects on Microorganisms

Refer also to abstracts 19250, 19259, 19293, 19309–19311, and 19319.

19458 THE RELATIONSHIP OF Cu^{2+} CONTENT TO THE RADIORESISTANCE OF YEAST. Gesswagner, D.; Altmann, H.; Szilvinyi, A. V.; Kaindl, K. (Reaktorzentrum, Seibersdorf, Austria). Int. J. Appl. Radiat. Isotop., 19: 152-3(Feb. 1968).

The relationship between the copper content and the radioresistance of living organisms and tissues received much attention. Investigations on the effect of Cu-ions at the molecular level gave very varying results. For example, it was shown that Cu^{2+} accelerates the radiolytic disintegration of amino acids and proteins, thus causing a favorable inactivation of enzymes by radiation treatment. In the case of nucleic acids, however, Cu^{2+} has a protective effect. Studies on yeasts with different Cu-content are described to determine the effect of metal ions on radioresistance. It was found that survival of yeast after up to 200,000 R irradiation was considerably increased by a high copper content. (auth) (UK)

19459 PRACTICAL METHODS USABLE FOR MEASUREMENT AND EVALUATION OF UVC IRRADIATION EQUIPMENTS. PART I. Oberdoerster, F.; Thielecke, K.-H. (Humboldt Univ., Berlin). Z. Gesam. Hyg. Ihre Grenzgeb., 11: 723-32(Oct. 1965). (In German).

The upper boundary for most biological effects of uv irradiation is about 315 nm, and the average minimum of the erythema curve is located at about 280 nm. The maximum specific microbiocidal action of uv irradiation is found between 250 and 270 nm, with only slight differences in sensitivities of various organisms. The microbiocidal action is diminished above and below these values, ending at about 315 nm. The effects are due to photochemical changes induced in the cells that inhibit, damage, or kill the organisms. These changes affect primarily the cell nuclei or increase the spontaneous mutation rate. The effectivity of uv irradiation depends on the dose used, and also on the distribution of the microorganisms in the irradiated substrate. The discontinuous distribution of the radiation quanta in space and time are important. The probablistic nature of the effect of uv irradiation produces an S-shaped curve. There is no maximum in this curve, and even the smallest dose of uv irradiation destroys some microorganisms in a population, while some microorganisms survive very high doses. The number of quanta required to kill microorganisms depends on their resistance, and ranges from 1 to higher values. Most vegetative forms of various types of bacteria differ little in their sensitivity to uv irradiation, but spore-formers and molds are about 10 times more resistant. (BBB)

19460 THE EFFECT OF METHYLGLYOXAL ON PHAGE INFECTION OF ESCHERICHIA COLI. Baylor, Martha B. (Marine Biological Lab., Woods Hole, Mass.); Egyud, Laszlo G. Virology 31: 380-2(Feb. 1967).

The influence of methylglyoxal (pyruvaldehyde) on coliphage infection and resistance of cells to infection induced by uv irradiation was studied. Cultures of Escherichia coli were infected with T-even coliphages in the presence of methylglyoxal. The infected complexes were assayed and the final phage yields were determined. Methylglyoxal reduced the average burst size from 100 to 300 in control cultures to an average of 20. Thus the capacity of the cell to produce mature phage was susceptible to inhibition by 10^{-3} M methylglyoxal. Cells pretreated with 10^{-3} M methylglyoxal for 15 min and infected with a single phage showed no increased resistance to uv light even after 20-min incubation. The inactivation rate was very close to that of free phage. Cells infected 10 min prior to addition of methylglyoxal were more resistant to uv inactivation than comparable controls. The lack of resistance to uv irradiation of cells pretreated with the drug before infection suggested that the early enzymes of the phage failed to be induced or that DNA replication was inhibited. The increased recombination frequencies and the increased resistance to uv treatment of cells infected before exposure of methylglyoxal indicated and DNA synthesis itself may not be affected. (BBB)

Radiosterilization and Radiopreservation

Refer also to abstract 19257.

19461 (NYO-3135-45) PREPARATION OF PETITIONS ON IRRADIATED FOODS. Annual Report, November 1, 1966–October 31, 1967. Garlock, Edward A. (Hazleton Labs., Inc., Falls Church, Va.). Dec. 13, 1967. Contract AT(30-1)-3135. 8p. Dep. CFSTI.

Petitions previously accepted for filing by the Food and Drug Administration included oranges, marine products, strawberries, and packaging materials. Products being considered for petitions are chicken, shrimp, and clams. A table is presented to show regulations and petitions on radiation preservation of bacon, wheat, potatoes, citrus fruits, marine products, strawberries, and ham. Another table is presented to show status of wholesomeness studies to support AEC irradiated foods petitions. (H.L.W.)

19462 LACK OF TOXICITY OF IRRADIATED FOOD IN A MOUSE DIET. Nutr. Rev., 24: 174-6(June 1966).

Irradiation of certain fats produces carbonyl compounds and other radiation products which are themselves perhaps nontoxic, but which may reduce the digestibility of fats and interfere with absorption of some fatty acids. The most disturbing evidence of the possible toxicity of irradiated foods was the finding of heart lesions in mice fed a composite diet of pork loin, evaporated milk, blanched carrots, chicken, and white potatoes, after irradiation of its components. Animals fed the composite irradiated diet developed dilatation, and in some cases rupture, of the left auricle. Of the constituents of the composite diet, fed singly after irradiation, only the evaporated milk was shown to produce the heart lesions. Later attempts to confirm these results were negative. No such toxic effects from the feeding of irradiated foodstuffs could be demonstrated in mice. The etiology of the cardiac lesions reported earlier could not be explained. (BBB)

19463 STERILIZATION EFFECT OF FAST ELECTRONS. Privora, M.; Cerny, P.; Pesek, J.; Synek, J. (Inst. for Epidemiology and Microbiology, Prague). Wiss. Z. Humboldt Univ. Berlin, Math.-Naturwiss. Reihe, 16: 195-6(1967). (In German).

Polyethylene, polypropylene, and other type plastic disposable syringes contaminated with suspensions of Micrococcus pyogenes var. aureus type Oxford Man 1/43, Escherichia coli, type III, Bacillus megatherium spores, and poliovirus, type III, were irradiated with electrons of maximum energies of 1.5 to 1.6 MeV. The doses used were 2 to 5 Mrad. At doses of 2 and 4 Mrad the spores and vegetative forms of all of the bacteria tested were killed, but the virus was not. At 2 Mrad about 1/2 of the viruses were destroyed, and at 4 Mrad about 3/4 of the viruses were destroyed. In some cases when the syringes were irradiated on 1 side only the vegetative forms of the bacteria were not killed. Next to the virus, the bacterial spores were most resistant to the irradiations. No reduction in virulence of the virus was observed after irradiation. Fast electrons appear to be advantageous for destruction of bacteria and molds on very small plastic objects, but their practical use for sterilization is limited by their smaller viricidal effects. In this respect, fast electrons are comparable with some chemical agents. (BBB)

19464 FOOD IRRADIATION: TOO LITTLE RESEARCH? TOO MUCH REGULATION? Battle, Mary T. Canner/Packer, 136: No. 6, 32(June 1967).

The roles that the Federal government and private industry have played in the development and use of radiation for the processing of foods and the influence that each has had on the progress made thus far are discussed. The most effective radiation doses for processing dehydrated onions, tomatoes, carrots, peas, leeks, bell pepper, cabbage, lima beans, celery, green beans, okra, and beets are presented; cooking time, organoleptic properties, and color were the criteria used. (B.H.S.)

19465 AN EVALUATION OF AORTIC VALVE HOMOGRAFTS STERILIZED BY ELECTRON BEAM ENERGY. Malm, James R.; Bowman, Frederick O. Jr.; Harris, Paul D.; Kowalik, A. T. W. (Presbyterian Hospital, New York). J. Thorac. Cardiovasc. Surg., 54: 471-7(Oct. 1967).

Techniques for preparation of frozen, irradiated aortic homografts are presented as an alternate method of homograft valve preservation. Changes in homograft aortic wall strength were measured following this and chemical methods of sterilization. Aortic valves for clinical use were obtained in unsterile condition from autopsy specimens of unselected donors less than 12 hr following death. Grafts were double-packed in polyethylene bags, stored at −70°C, and sterilized by high-voltage electron beam irradiation. Irradiation of the graft in the frozen state was done at doses of 2.0 to 2.2 Mrad and exposure times of 5 to 6 seconds. A method designed to evaluate the strength of aortic homografts is described. The influence of sterilization by the two methods on

gross morphology and tensile strength of the grafts was striking. There was a consistent reduction in tensile strength following immersion sterilization with β-propiolactone, the average being 35%, but no tensile strength changes were observed following use of the frozen irradiation technique. Preservation of graft tensile strength and geometry, proper selection of graft size, and a precise technique for valve implantation were important in obtaining a satisfactory hemodynamic result. Clinical results with the use of the radiosterilized aortic homograft valves in 23 patients are reported. These valves functioned satisfactorily up to 11 months. The absence of arterial emboli and low incidence of aortic-diastolic murmurs suggested that β-irradiated valves compared favorably with other preserved grafts and prostheses. (BBB)

19466 DEVELOPMENT OF FLEXIBLE CONTAINERS FOR IRRADIATED FOODS. I. SCREENING OF COMMERCIALLY AVAILABLE PLASTIC LAMINATES. Killoran, John J.; Breyer, Jacob D.; Wierbicki, E. (Army Natick Labs., Mass.). Food Technol., 21: 73-7(Aug. 1967).

Five commercially available plastic laminates were screened for in-package radiation sterilization processing of bacon, ham, and pork. One plastic laminate was transparent. The food-contacting materials were: medium density or high density polyethylene, and polyvinyl chloride. All samples were packed under vacuum. Control samples were non-irradiated meat products in flexible pouches (stored at −29°C). The test samples were the meat products packaged in flexible pouches, irradiated (4.5 to 5.6 Mrad, ^{60}Co), and stored at 23°C and 50% relative humidity for 12 months. Evaluation included observations for odor, leakage, and color changes and determination of the physical changes in flexible pouches (heat seal strength, burst strength, and bond strength). Each meat product was subjected to organoleptic and chemical testing. At the end of six months, 4 of the flexible packaging materials were eliminated because of off-odor and/or off-color that developed in the meat products. Pinholes, delamination, and loss of vacuum were noted in the pouches. One laminate, employing medium density polyethylene as the food-contacting material, was found to be satisfactory for the storage of the meat products for one year. (BBB)

19467 STUDIES ON THE EFFECT OF GAMMA IRRADIATION ON WHEAT FLOUR. Doguchi, Masao (Tokyo Laboratory for Medical Science). Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku, No. 24, 1-54(Mar. 1967). (In Japanese).

A study was made on the changes of the properties of wheat flour, wheat starch, and gluten induced by gamma irradiation up to a maximum dose of 10 Mrad, with the purpose of providing basic information for the development of new products, as well as for killing insects for food preservation. Since gluten is an important factor in determining the quality of wheat flour, most of the research was on the clarification of its denaturation mechanism. The requirement for the properties of flour differs with its purpose. It was found that the high-viscosity flour with a large starch content could be changed into flour of medium viscosity, and further into flour of low viscosity, by gamma irradiation. The information obtained on the effects of various doses on the property changes of wheat flour and on denaturation of wheat starch and gluten, is considered as highly significant in the application of radiations in the food industry. (NSA of Japan) (TSS)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 19029.

19468 (UCRL-Trans-10215) ON THE METALLURGY OF ELECTRON-BEAM MELTING. PART I. MEASUREMENT OF STEEL BATH TEMPERATURE WITH AN OBJECTIVE COLOR PYROMETER. Esser, Fred; Scharf, Gerhard; Rumberg, Dieter. Translated by P. U. Unger for Univ. of California Lawrence Radiation Lab., Livermore, from Neue Huette, 10: 333-8 (1965). 21p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

Techniques and equipment developed to measure the temperature of molten steel surfaces in a multichamber electron-beam furnace, by use of a color pyrometer, are described. Aspects considered are radiation intensity, emission factors, spectral transmission of observation windows, condensation on windows, measurement circuits, results and evaluation of experimental measurements. (P.G.C.)

19469 URANIUM IN INDUSTRY. Seedhouse, K. G. (United Kingdom Atomic Energy Authority, Risley, Eng.). Chem. Process. (London), 14: 30-5(Mar. 1968).

Large quantities of depleted uranium are available for nonnuclear applications. The wide range of potential industrial uses for the metal, its alloys, and its compounds is described. (auth) (UK)

19470 FACTORS INFLUENCING THE IGNITION OF METALLIC PLUTONIUM. Pitts, Sam H. Jr. (Dow Chemical Co., Golden, Colo.). Nucl. Safety, 9: 112-19(Mar.-Apr. 1968).

The factors that influence the ignition of plutonium were investigated experimentally and found to be related to sample size and geometry or to the surface composition. The ignition temperature decreased as the sample surface area was increased, as the weight of plutonium filings was increased, and as slower heating rates were used. Samples heated at constant, elevated temperatures ignited at lower temperatures than those heated at a constantly increasing temperature. Thin foil coupons ignited at lower temperatures when they contained induced internal stresses. Lower ignition temperatures were obtained by forming PuO on the sample surfaces. (auth)

19471 LIQUID METALS. March, N. H. International Series of Monographs in Natural Philosophy. Volume 15. Oxford, Pergamon Press, 1968. 140p. 60s.

The subject is reviewed under the following Chapter headings: Outline; liquid structure; electron theory; statistical theory; pair potentials; melting; electrical transport; liquid dynamics; electron states. (UK)

Corrosion and Erosion

Refer also to abstracts 19043 and 19586.

19472 (66-C-326) SOME PHYSICAL AND CHEMICAL PROPERTIES OF GRAIN BOUNDARIES. Aust, K. T. (General Electric Co., Schenectady, N. Y. Research and Development Center). Sept. 1966. 19p. (CONF-660836-1).

From Conference on Physical and Chemical Characteristics of Surfaces and Interfaces, Raquette Lake, N. Y.

Experimental data on the energy, migration, and corrosion behavior of grain boundaries in metals are presented. The interfacial energy data provide support for the coincidence lattice model of the structure of high-angle boundaries. The results of the boundary migration studies are in agreement with the theory of impurity-controlled motion. The work on grain-boundary corrosion demonstrates a useful approach to intergranular corrosion problems of commercial alloys. (auth)

19473 (COO-1319-53) A STUDY OF THE MECHANISM OF STRESS CORROSION CRACKING IN THE IRON-NICKEL-CHROMIUM ALLOY SYSTEM. Quarterly Report, September 17, 1966-December 16, 1966. Staehle, R. W. (Ohio State Univ. Research Foundation, Columbus). Jan. 30, 1967. Contract AT(11-1)-1319. 34p. Dep. CFSTI.

Reported are results from circulating autoclave studies, optical metallography, polarization studies in boiling $MgCl_2$, true stress true-strain studies, and dynamic straining experiments conducted in solution at selected potentials. A significant result from the circulating autoclave studies shows that the cracking rate of stainless steel below 150°F is greatly reduced. (auth)

19474 (DP(NASA)-1130) ROLE OF HYDROGEN CHLORIDE IN HOT-SALT STRESS CORROSION CRACKING OF TITANIUM-ALUMINUM ALLOYS. Ondrejcin, R. S.; Louthan, M. R. Jr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Dec. 1967. Contract AT(07-2)-1. 28p. Dep. CFSTI.

The reactions of titanium-aluminum alloys with anhydrous HCl gas were studied, and the reaction products were found to be $TiCl_2$, $TiCl_3$, $TiCl_4$, Al_2Cl_6, and H_2. These products are considered to be intermediates in the hot-salt stress corrosion cracking of titanium-aluminum alloys. These products are not normally identified because they oxidize and hydrolyze in the presence of oxygen, moisture, and heat. Fractographic examination of Ti-8Al-1Mo-1V specimens cracked by hot salt and HCl showed the same fracture mechanism in both cases—mechanical rupture accompanied by dislocation movement. It is proposed that stress-sorption is the mechanism of cracking, and that atomic hydrogen is the species sorbed. (auth)

19475 (IN-1134) CORROSION EVALUATION OF EQUIPMENT USED FOR REPROCESSING ZIRCONIUM ALLOY NUCLEAR FUELS. Zimmerman, C. A.; Hoffman, T. L. (Idaho Nuclear Corp., Idaho Falls). Feb. 1968. Contract AT(10-1)-1230. 10p. Dep. CFSTI.

Corrosion rates for Monel-400 and various stainless steels in process solutions were determined in laboratory studies and in plant service. The plant service period included the first reprocessing of zirconium alloy nuclear fuels using boric acid as a soluble poison during dissolution. Corrosion rates for a Monel-400 dissolver using hydrofluoric-fluoboric acid dissolvent and sulfuric and chromic acids for cleanout ranged between two and eight mils per month. Corrosion rates for stainless steel plates containing boron as a fixed poison in the first cycle product evaporator were very low. The low corrosion rates for this and other process equipment indicate that the system can be used for future reprocessing operations. (auth)

19476 (MSAR-68-14) EFFECT OF HIGH-TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. Quarterly Progress Report, October-December 1967. (MSA Research Corp., Evans City, Pa.). Jan. 1968. Contract AT(11-1)-765. 19p. Dep. CFSTI.

A program for determination of the effects of high temperature sodium on the mechanical properties of candidate alloys for the LMFBR is continuing. Test materials consisting of SS 304, SS 316, Cr-Mo steel, Croloy 5, and Croloy 5Ti have been selected, the specimens are in preparation, and the test program has been specified. Four static retorts have been installed. Operations of the test loops for high-carbon, high-oxygen, and "clean" sodium environments were checked. Two extensometers performed satisfactorily for short run high-temperature cycles and are undergoing further heat run testing. Surface-tension measurements were made in an attempt to develop a technique for measuring sodium impurities. (L.C.L.)

19477 (NASA-SP-5090) SURFACE TREATMENTS FOR PRECIPITATION-HARDENING STAINLESS STEELS. Hall, A. M. (Battelle Memorial Inst., Columbus, Ohio). [Apr. 27, 1967]. Contract DA-01-021-AMC-11651(Z). 62p. Dep. CFSTI.

Selected surface treatments are applied to precipitation-hardenable stainless steels. The treatments covered are hard surfacing, electroplating, electroless plating, carburizing and decarburizing, nitriding, burnishing and other finishing operations, explosive hardening, planishing, and peening. Each treatment is described and its application to the precipitation-hardenable stainless steels is discussed. Reasons for using the treatments are discussed, problem areas are identified, and recommendations for research are made. (auth)

19478 (SC-CR-67-2830) STUDY OF THE CHEMICAL INTEGRITY OF RADIOISOTOPE CONTAINMENT MATERIALS IN LAUNCH ABORT ENVIRONMENTS. Gregson, W. Jr. (TRW Systems, Redondo Beach, Calif.). Dec. 1967. Contract 48-4912. 111p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

Three representative radioisotope containment materials (316 stainless steel, Haynes 25, and tantalum) were tested in controlled flame environments along with other materials (aluminum, magnesium, and graphite) to determine the degree of hazard to be expected from the hostile environment from an on-pad abort. Qualitative and quantitative results are presented and include

gross damage to the materials and metallurgical degradation from chemical interaction. (auth)

19479 (UCID-15256) DELAYED CRACKING STUDY IN U-7.5 PERCENT Nb-2.5 PERCENT Zr. Peterson, C. A. W.; Steele, W. J. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 19, 1967. Contract W-7405-eng-48. 37p. Dep. CFSTI.

Two types of tests were used to evaluate the delayed cracking propensity in U-7.5% Nb-2.5% Zr (Mulberry): sustained loading near the yield strength in dry and wet air; and dynamic testing to failure over a range of strain rates (0.05 to 0.005 in./in./min) in dry air, wet air, and vacuum. Two conditions of constitution were examined: solution treated by quenching from the gamma field, and solution treated plus aging at 150°C for 1 hr. The effects of mechanical notches and pre-existing intergranular penetrations were also observed. Specimens which had been machined after heat treatment and thus presented a clean, machined surface to the atmosphere while under stress did not fail in creep or show low elongation at low strain rates. Tests to failure produced ductile fracture surfaces. Indications of surface damage by oxidation, gouging or scoring to form minute notches, and inclusions, as well as intergranular penetration and substructural contamination, are seen in the many optical and electron microstructures of brittle fractures. The gamma-quenched specimens so contaminated appeared to be more susceptible to failure in the humid environment than samples heat-treated at 150°C or machined after all heat treatments. Resistivity measurements and x-ray data show that gamma-quenched Mulberry specimens are highly stressed, particularly on the surface, from the quenching. The 150°C aging treatment relieves this condition, as evidenced by the sharpening of the γ-U(110) line and by a pronounced drop in electrical resistance. Of course, machining the surface would also relieve stresses on the surface. Apparently, failure occurs in U-7.5% Nb-2.5% Zr when the surface is both in a state of high residual tensile stress and is impaired by localized stress-raisers, such as oxide inclusions (particularly intergranular penetrations) and mechanical notches. When these same surfaces are relieved of stress by fine machining or etching and freed from oxide layers, delayed cracking does not occur, even near the nominal yield strength of the alloy. (auth)

19480 (WAPD-TM-647) THE CORROSION AND HYDROGEN ABSORPTION PROPERTIES OF ZIRCALOY-4 ALLOYS CONTAINING ADDITIONS OF NIOBIUM. Kass, S. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec. 1967. Contract AT(11-1)-Gen-14. 23p. Dep. CFSTI.

Results are presented of experiments designed to measure H absorption characteristics and corrosion kinetics of Zircaloy-4 containing additions of 0.5 and 1.0% Nb. It was determined that the alloys containing Nb showed somewhat higher corrosion rates and approximately equivalent H pickup characteristics in both high-temperature water and steam compared with Zircaloy-4. It was also determined that addition of these amounts of Nb gave slightly increased strength in the alpha annealed condition without serious loss of ductility and that the properties of the alloys were not appreciably affected by metallurgical structure. It was concluded that no significant advantage was gained by the addition of Nb. (P.G.C.)

19481 (BNWL-tr-25) CORROSION PROBLEMS POSED BY THE USE OF AUSTENITIC "CHROME-NICKEL-IRON" IN THE NUCLEAR ENVIRONMENT. Coriou, H.; Grall, L.; Pelras, M. Translated by Roberta L. Bush and Spencer H. Bush (Battelle-Northwest, Richland, Wash.), from Energ. Nuc. (Paris), 9: 303-13(1967). 42p. Dep. CFSTI. JCL $4.60 fs, $1.46 mf.

This paper was abstracted from the original language and appeared in NSA as 22: 8697. (L.C.L.)

19482 TIN-ALUMINUM-MOLYBDENUM OXIDATION PROTECTIVE COATINGS FOR TANTALUM ALLOY AEROSPACE PARTS. Sama, L.; Reznik, B. (Sylvania Electric Products Inc., Hicksville, N. Y.). Electrochem. Technol., 6: 113-19 (Mar.-Apr. 1968).

The application, structure, and physical properties of high-temperature, oxidation-resistant Sn-Al-Mo coatings for tantalum alloys are described. Typical leading edge, heat shield, and other parts intended for re-entry or aerospace use are illustrated and oxidation data presented for test samples and parts. Tests included furnace, torch, arc-jet, and burner rig in atmospheric and reduced-pressure environments obtained primarily in outside aerospace test facilities. Advantages and disadvantages of the coating system are discussed. (auth)

19483 LOW-TEMPERATURE HYDRIDING OF ZIRCALOY-2 AND TITANIUM IN AQUEOUS SOLUTIONS. Charlot, L. A.; Westerman, R. E. (Battelle Memorial Inst., Richland, Wash.). Contract AT(4501)-1830. Electrochem. Technol., 6: 132-7 (Mar.-Apr. 1968).

Zircaloy-2 and titanium specimens were made cathodic by means of applied or galvanic currents in several aqueous electrolytes at temperatures less than 100°C. For vapor-blasted material, hybriding occurred at potentials as low as 0.5 V in the case of both Zircaloy-2 and titanium. Etched material was found to be much more resistant to hydriding. Titanium U-bend samples galvanically coupled to aluminum absorbed significant quantities of hydride without failure. The hydride platelets were found to precipitate in a stress-dependent fashion. (auth)

19484 INVESTIGATION OF THE CORROSION RESISTANCE AND ELECTROCHEMICAL AND MECHANICAL PROPERTIES OF ALLOYS OF THE TITANIUM-NIOBIUM SYSTEM. Andreeva, V. V.; Kazarin, V. I.; Alekseeva, S. G.; Glazunov, S. G. Korroz. Metal. Splavov, No. 2, 43-58(1965). (In Russian).

Ti alloys with 2 to 50% Nb were studied. Niobium-doping of Ti considerably increases its tensile strength and hardness. After hot forging, the Ti-20 Nb alloy has a tensile strength approximating 104 Mn/m^2 (Ti has about 60 Mn/m^2) and elongation of about 11% (Ti approximately 18%). The corrosion resistance of the alloys in solutions of nonoxidizing acids is considerably higher than the corrosion resistance of Ti. In acids such as HNO_3 the corrosion resistance of Ti and Ti-Nb alloys is the same. With increased Nb content in the alloys, the critical density of the passivation current decreases and the stationary potential shifts toward more positive values. (Rev. Met. Lit.)

19485 INVESTIGATION OF THE CORROSION RESISTANCE AND THE ELECTROCHEMICAL AND MECHANICAL PROPERTIES OF ALLOYS OF THE NIOBIUM-TITANIUM SYSTEM. Glukhova, A. I.; Andreeva, V. V.; Glazunov, S. G.; Solonia, O. P.; Nikulova, V. F. Korroz. Metal. Splavov, No. 2, 29-42(1965). (In Russian).

Nb alloys with 2 to 40% Ti have a high corrosion resistance in solutions of mineral acids at 40°C. With increased Ti content, the corrosion resistance of the alloys decreases. The corrosion is highest in acid media at a 100 mV potential. At higher negative potentials a hydride layer is formed and the metal becomes brittle as a result of the diffusion of hydrogen in the metal. (Rev. Met. Lit.)

19486 SURFACE TREATMENT OF THE ALLOYS OF ZIRCONIUM BY FUSED SODIUM NITRATE. Hardy-Grena, C.; Avogadro, A.; Wurm, J. G. (CCR-EURATOM, Ispra, Italy). J. Nucl. Mater., 25: 296-303(1968). (In French).

The protection of zirconium alloys against hydrogenation has been attempted by means of a new method of surface oxidation, involving treatment at 450°C in a bath of molten sodium nitrate. Corrosion tests in hydrogen and in chlorine-free terphenyl gave satisfactory results, but alloys subjected to impure terphenyl (containing 5 ppM of chlorine) were very strongly hydrogenated, probably by the catalytic action of chlorine. (auth)

19487 WEAR RESISTANCE OF Cu-Fe ALLOYS AS OIL-LUBRICATED SLIDING CONTACTS. Takeuchi, Hisasuke; Kobayashi, Toyoji (Hitachi Research Lab., Japan). Nippon Kinzoku Gakkaishi, 31: 1133-9(1967). (In Japanese).

Contact materials used in oil-filled top changers for regulating the voltage of transformers or electric locomotives must be wear resistant, because the accumulation of particles produced from the wear of sliding contacts tends to cause a high voltage breakdown. The most desirable pair of electro-conductive materials, which would make the oil-lubricated current collector maintenance-free for a long period of time was studied. A series of wear tests were carried out with fourteen different materials contacted with a copper plate, using (a) a horizontal sliding type wear tester without current flowing, and (b) an actual high voltage tap changer for the electric locomotive with current flowing through the contacts. Materials tested were Cu-Fe cast alloys, Ag-W and Cu-W sintered alloys, aluminum bronze, and manganese bronze. It was found that by measuring the weight loss and roughness of the worn surfaces, of a group of Cu-Fe alloys, the wear resistant properties of these alloys, followed by Ag-W and Cu-W alloys could be shown. The wear resistance of the Cu-Fe alloys was improved by heat treatments; by quenching and tempering, a hard contact material with relatively high conductivity was obtained. The microstructure of Cu-Fe alloys consisted of two phases, hard iron-rich phase and soft copper-rich one. The difference of micro-hardness between the two phases was enhanced by heat treatments. This was considered to account for the superior wear resistance of the alloys, particularly when heat-treated. When Cu-Fe alloys were contacted with Cr-Cu alloys, the total weight loss was much less than that when contacted with pure copper. (auth)

19488 OXIDATION PROTECTION OF MOLYBDENUM BY A $MoSi_2$/SnAl PROTECTIVE LAYER. Stecher, P.; Lux, B. (Centre de Recherche, Geneva). J. Less-Common Metals, 14: 407-26(Apr. 1968). (In German).

The production and the structure of a new kind of protective coating are described. The coating consists of a porous $MoSi_2$ layer impregnated with a low-melting tin–aluminum alloy. The SnAl phase, which is liquid at oxidation temperatures, forms a protective Al_2O_3 film and, owing to its mobility, confers self-healing properties to the coating in case fissures occur. The life of coated unalloyed molybdenum and Mo-TZM specimens in static and cyclic oxidation tests was examined. The protective $MoSi_2$-coating combined with a tin–aluminum phase is particularly interesting in view of its increased reliability with respect to possible failures arising through the occurrence of local defects after short oxidation times. The loss of the protective effect during oxidation is attributed to structural modifications within the coating. (auth)

19489 LOW TEMPERATURE (< 300°C) OXIDATION OF ZIRCALOY-2 WATER. Cox, B. (Chalk River Nuclear Labs., Ontario). J. Nucl. Mater., 25: 310-21(1968).

Measurements of the oxidation of two batches of Zircaloy-2 at 200, 250, 275 and 300°C in demineralized water, combined with earlier unpublished data at intermediate temperatures, have shown that published extrapolations of the oxidation rate downward in temperature gave inaccurate predictions. Neither the kinetic rate law, nor the temperature coefficient was regular, the latter being low for temperatures between 260 and 290°C, and for exposure times below ~50 days. The irregularities indicated successive changes in the balance between a series of oxidation controlling processes. Interferometer measurements, optical and electron microscopy have shown that up to 40% of the weight gain resulted from the formation of local regions of thicker oxide (together with some oxygen dissolution in the metal). Nucleation of spinel-like crystals (possibly of magnetite) on the oxide surface also contributed to the weight gain. Their deposition was probably controlled by the local electrical properties of the oxide film. (auth)

Preparation and Fabrication

Refer also to abstracts 18867 and 19477.

19490 (NASA-SP-5086) SHAPING OF PRECIPITATION-HARDENING STAINLESS STEELS BY CASTING AND POWDER-METALLURGY. Kura, J. G.; Barth, V. D.; McIntire, H. O. (Battelle Memorial Inst., Columbus, Ohio). [Apr. 20, 1966]. Contract DA-01-021-AMC-11651(Z). 50p. Dep. CFSTI.

The state of the art of making shapes of precipitation-hardenable stainless steels by methods other than machining from wrought materials is reviewed. The methods reviewed are casting and powder metallurgy. Of these methods, only casting is extensively practiced. Powder metallurgy is a promising procedure for 17-4 PH stainless, but techniques are not well advanced for handling the grades that contain titanium or aluminum such as PH 15-7 Mo and A-286. (auth)

19491 (UCRL-Trans-10220) ON THE METALLURGY OF ELECTRON-BEAM MELTING. PART II. VOLATILIZATION PROCESSES IN THE 200-kw MULTICHAMBER ELECTRON-BEAM FURNACE. Scharf, Gerhardt; Esser, Fred; Rumberg, Dieter. Translated by P. U. Unger for Univ. of California Lawrence Radiation Lab., Livermore, from Neue Huette, 11: No. 1, 19-27(1966). 34p. Dep. CFSTI. JCL $3.60 fs, $1.25 mf.

The metallurgical potentialities of melting steel in an electron beam furnace are discussed. Topics covered include the melting process, kinetics of volatilization, volatilization behavior of Cr and Mn alloying elements as a function of specific energy consumption, k values for volatilization of Cr and Mn under remelting conditions, and the effect of programmed beam guidance on temperature distribution and volatilization. It was determined that programmed beam guidance during melting can lead to elimination of quasi-stationary temperature fields and that the method offers greater metallurgical flexibility than other vacuum melting processes. (P.G.C.)

19492 ELECTROWINNING OF NIOBIUM. Wong, M. M.; Kirby, D. E. (Bureau of Mines, Boulder City, Nev.). Electrochem. Technol., 6: 119-23(Mar.-Apr. 1968).

Operating parameters for electrowinning of niobium from the $KCl-KF-K_2NbF_7-Nb_2O_5$ electrolyte system were studied. Best results were obtained with the following operating conditions: electrolyte composition, 41.2 mole % KCl, 55.0 mole % KF, 2.7 mole % K_2NbF_7, and 1.1 mole % Nb_2O_5; applied voltage, 2.5 V; temperature, 750°C. Successive electrodepositions from the same electrolyte, with a replenishment of Nb_2O_5 and K_2NbF_7 after each deposition, maintained a steady level of performance and produced metal with an average oxygen content of approximately 400 ppM. (auth)

19493 NEW METALWORKING TECHNIQUES BACK CANADA'S BOLD MOVE TO MORE EFFICIENT NUCLEAR POWER. Weissmann, T. E. Can. Mach. Metalwork., 76: 78-82(June 1965).

Fabrication, machining and welding of stainless steel, Zircaloy, and SAP tubes are described with emphasis on the special techniques, required by the small tolerances specified. Spiral ribs on fuel sheaths presented a difficult problem. A process called pressure-diffusion bonding and magnetic pulses was used in some of the forming operations. Since the fuel pellets were 2.40 wt % enriched uranium, criticality control methods were essential. (F.S.A.)

19494 APPLICATION OF THE TRACER TECHNIQUE IN THE INVESTIGATION OF SOLID-PHASES MIXING IN THE TAPERED-BED COLUMN. Milosavljevic, Jovan; Jovanovic, Dura Nukl. Energ., 4: No. 3, 6-10(1967). (In Slovak).

During an investigation concerning the application of the fluidized-bed technique in the uranium metal production technology project a tapered fluid-bed unit which represents an up-to-date technical achievement in the field of the fluidized-bed technique was built. The main task of the first experiments was to determine the basic dynamic parameters with particular attention devoted to the mixing rate of feeding material with bed material under the predetermined fluidization conditions. It was considered that structural sand would best serve for the formation of the initial bed as well as for the feeding material labeled with a suitable isotope, such as ^{59}Fe. Feeding of the labeled portion into the fluidized sand was carefully controlled at the predetermined rate. In order to keep the bed level constant, withdrawal of the "product" at the bottom of the column, was carried out at the same rate as the feeding. Experiments showed that the applied technique assured the obtaining of quite satisfactory and reliable results, at a confidence level of about 90%. (auth)

19495 INVESTIGATION OF THE THERMAL CONDITIONS IN THE REDUCTION BOMB DURING PREHEATING OF THE UF_4-Mg CHARGE. Filipovic, Mirjana; Milosavljevic, Jovan. Nukl. Energ., 4: No. 3, 11-14(1967). (In Slovak).

During the investigation of the thermite reduction of green salt–magnesium metal blends, it was necessary to escale the charge from laboratory size to a pilot plant. In addition to controlling variables governing the reduction yield, it was also necessary to determine the heat distribution during the preheating period in order to have insight into the firing pattern. For each new constructed reduction shell, the temperature distribution was measured and recorded. Under normal working conditions, there was a temperature gradient existing between the bomb lining and the central part of the charge, the former being always cooler. Those temperature differences varied inversely with the bomb capacity. For the 10-kilo uranium bomb the difference varied between 5 and 330°C, for the 25-kilo bomb it varied between 100 and 250°C, while for the 50-kilo bomb this difference was 75 to 280°C. The time necessary for the self-ignition of a blend from the moment of its placing into the uniformly preheated furnace to 700 ± 10°C was also determined. For the 10-kilo bomb the preheating time was 3 hours, for the 25-kilo bomb it was 4 hours, while for the 50-kilo bomb it was 5 to 6 hours. Knowledge of the temperature distribution made possible the obtaining of an approximate picture of the central part temperature along the whole charge at the moment of self-ignition. (auth)

19496 REDUCING ENDS OF MOLYBDENUM TUBES. Korolev, V. N.; Galakhov, A. I. Kuznechno-Shtampovochnye Proizvod., No. 7, 22-6(1967). (In Russian).

Sintered-molybdenum tubes, 8 and 12 mm in diameter with a wall thickness of 1 mm, were annealed in hydrogen at 880 to 900°C for 30 min. The tube ends were reduced in conical dies with an angle of taper of 10 to 65° or nosed in spherical dies with a mean radius 4 or 6 mm. The deformation was done at 20 and 200 to 240°C at a rate of 1.5 to 3.0 mm/sec (reduction in conical dies) and 1.2 mm/sec (nosing in spherical dies); water base colloidal graphite compositions B-0 and B-1 (GOST 5245-50) were used as lubricants. Depending on the operation conditions, in nosing tubes in spherical dies, the working coefficient of reduction $K = d_m/D_m$ (d_m and D_m are the mean diameter of the reduced and initial tube, respectively) varied from 0.48 to 0.50 to 0.63 to 0.65. In reducing tubes in conical dies, the optimum angle of taper of the dies was found to be 15°. The working coefficient, in this case, varied from 0.6 to 0.62 to 0.85 to 0.87. When a required reduction of the tube end diameter cannot be obtained with single operation, a second operation is performed after

process annealing (in hydrogen at 880 to 900°C for 30 min). Finished parts should be stress relieved in vacuum or in a hydrogen atmosphere at 800 to 850°C for 25 to 30 min. (ATD)

19497 LASERS FIND USE FOR PRODUCTION WELDING. Can. Mach. Metalwork., 78: 86-7; 91(May 1967).

Laser welding is used on a production basis for joining a 0.002 in. thick cylindrical Ta sleeve to a Mo-base collar in the fabrication of electron tubes. (TSS)

19498 MANUFACTURE OF BERYLLIUM. Green, R. E. Mach. Prod. Eng., 110: 1072-9(May 17, 1967).

Beryllium supplied as pebbles or flake is melted in a vacuum induction heated melting furnace and cast in mild steel molds insulated with alumina. The ingots produced are large grained and porous and must be converted into granular swarf as the first stage in the production of powdered Be. The swarf is produced at normal cutting speeds and feed rates using tools with throw-away carbide tips. The powder is separated from Fe impurities in an electromagnetic separator, then ground by two contrarotating Be-faced disks. Billets are produced by hot pressing in hard graphite molds. (UK)

19499 EXAMPLES OF WELDING TECHNOLOGY EMPLOYED IN NUCLEAR REACTOR CONSTRUCTION. Zurn, Herbert. Z. Schweisstech., 56: 383-415(1966). (In German).

A general review of welding problems in nuclear reactor technology is given. The principal types of reactors, their most important structural elements and the general problems of welding occurring in construction are surveyed and extensively tabulated. The welding of fuel elements, cylindrical structural elements (protective tubes and heating elements), thermocouples and sensors, special research devices, pressure and containment vessels, fillers, steam converters and undercoolers and safety containers is discussed in detail with the aid of examples taken from the literature. (Rev. Metal Lit.)

19500 PREPARATION OF URANIUM BY MEANS OF REDUCTION OF UO_2 BY CALCIUM VAPOR. Oki, Takeo; Tanikawa, Jun (Nagoya Univ., Japan). Nippon Kinzoku Gakkaishi, 31: 1048-52(Sept. 1967). (In Japanese).

Experiments on the reduction of UO_2 by calcium vapor and melting of the coarse (produced) uranium powder have been performed to determine the optimum condition for preparing a uranium metal powder with good fusibility and high purity. Further experiments for preparing a small uranium metal ingot from the produced uranium powder have been done. It was found that optimum condition for preparing coarse uranium powder is: reaction temperature, 1100°C; Ca/UO_2 mol-ratio, 9; reaction time, 2 to 3 hr (in case of this experimental scale); yield percentage of coarse uranium powder (gray-white) is more than 90%. The coarse uranium powder (gray-white) has better fusibility than the fine one (black or brown-black). Favorable conditions for making small uranium ingot are: temperature, >1200°C; atmosphere, argon gas (1 atm); metallic calcium is put outside of the crucible in the vessel. Purity of small uranium ingot obtained is more than 99.9%. Contents of impurities (typical are: Al, 3.2 ppM; Cd, 0.3 ppM; Co, 0.8 ppM; Cr, 7 ppM; Fe, 37 ppM; Mg, 14.5 ppM; Mn, 3.4 ppM; Ni, 54 ppM; Si, 43 ppM; Cu, 7 ppM; P, 44 ppM; Pb, 0.4 ppM. (NSA of Japan)

19501 EXPERIMENTAL PRODUCTION OF METALLIC URANIUM AND THORIUM AT THE ATOMIC ENERGY INSTITUTE. de Souza Santos, Tharcisio D; Haydt, Heliton M.; de Freitas, Clauer Trench (Instituto de Energia Atomica, Sao Paulo, Brazil). Met. ABM (Ass. Brasil. Metais), 21: 147-52(Feb. 1965). (In Portuguese).

Experimental production of metallic uranium and thorium at Atomic Energy Institute in Brazil; characteristics of materials employed, and methods and equipment used in their reduction; vacuum melting and casting of uranium; processing of metals by powder metallurgy. (auth)

19502 METALLIC COATINGS BY PLASMA JET. Matting, A.; Steffens, Hans-Dieter (Technische Hochschule, Hanover). Z. Metallk., 59: 13-17(Jan. 1968). (In German).

A high-current direct-current arc is available for producing plasmas used in coatings. The coating of materials is effected according to the principle of the closed arc. The coating materials are introduced into the beam in powder form. Qualitative improvements of the adhesion tensile strength by employing the plasma jet procedure over that resulting from ordinary spraying procedures are possible. However, the higher costs appear to be warranted only for refractory materials. Thus molybdenum and tungsten can be applied to other suitably prepared metallic base materials. The adhesion is mainly due to diffusion and chemical reaction. The mechanical bonding is less essential. As soon as the equipment and powders become cheaper it is to be expected that the application of coatings by plasma jet will be useful and economical in the areas of mechanical engineering, chemical equipment, transportation etc., possibly with further improvements by coating under inert atmosphere. (auth)

19503 GROWTH OF ORIENTED NIOBIUM BICRYSTALS BY ARC-ZONE MELTING. Brehm, W. F. Jr.; Gregg, J. L. (Cornell Univ., Ithaca, N. Y.). J. Less-Common Metals, 14: 463-5 (Apr. 1968). (BNWL-SA-1491).

A modification of Carlson, Schmidt, and Paulsen's arc-zone technique was used for bicrystal growth. A length of single-crystal seed rod was cut, ground flat on top, and cut in half. The two halves were placed with the original ends opposite and one end welded together. This procedure produced the bicrystal seed of two single crystals having a common [110] with a simple tilt of a [100]. The seed and a getter button were placed in a hearth under argon. A molten zone about $\frac{1}{4}$ in. wide was obtained about $\frac{1}{4}$ in. from the end of the seed and the motion of the hearth started by engaging the gear drive. The molten zone thus traversed the length of the seed rod, melting the two single crystals together, producing a grain boundary of the desired orientation between them on resolidification. (M.C.G.)

19504 THE CLADDING OF STEEL WITH REFRACTORY METALS, ESPECIALLY MOLYBDENUM, WITH THE AID OF THE SHOCK WAVE TECHNIQUE. Boehm, Georg Z. Metallk., 59: 104-11(Feb. 1968). (In German).

The explosion cladding technique is described and compared with conventional cladding methods. A description is given of the experimental procedure, and the results using the titanium, tantalum, and molybdenum are discussed. Some characteristic phase transformations in the bonding zone and the strength values obtained from experiment are considered in detail. The results of the welding tests with the argon arc and the electron beam methods are described. A newly developed technique for the welding of molybdenum is given. (tr-auth)

19505 ELECTRON BEAM WELDING AS A PRODUCTION TOOL. Mach. Shop Eng. Mfg, 28: 193-4(May 1967).

Electron beam welding is particularly suitable for welding Ti, Zr, Mo, and Nb because the use of vacuum produces high-purity welds with no gas or solid inclusions. The beam can be focused accurately on the workpiece and can be switched to give both short and consistent weld times. Heat concentrations, much greater than those possible with conventional arc welding, can be produced. Joints have narrow welds and localized heat affected zones. (Rev. Metal. Lit.)

19506 METHOD FOR PRODUCING A NUCLEAR FUEL ROD. Iizuka, Tomio (to Hitachi Ltd.). Japanese Patent 1967-9000. Apr. 28, 1967. Filed Nov. 1, 1963.

The method proposed is used for producing a uranium-oxide pellet fuel rod. The welding involved is simplified. One end of the cladding tube whose other end has been sealed, is expanded in diameter. Into this expanded part are inserted a cap (body) whose diameter is a little larger than the inside diameter of the tube-part, a push rod through which a gas in-take hole is cut, and around the circumference a device for keeping the air-tightness between the expanded part and the push rod itself. Then, this expanded part is run through the hole of a die, bringing the cap into a tight contact with the inside (of the expanded part) of the cladding tube. The tube end and the cap are welded. (NSA of Japan)

19507 METHOD FOR PRODUCING NUCLEAR FUEL PELLETS. Okajima, Yasujiro (to Hitachi Ltd.). Japanese Patent 1967-12025. July 8, 1967. Filed Oct. 22, 1963.

By the method proposed, sintered nuclear-fuel pellets, having high density and no defects, can be produced with high precision. To the powder of uranium oxide (or a powder with uranium oxide as its main content) is added a molding agent, which is a mixture of polyethylene glycol and polyvinyl alcohol in a weight ratio of 1: 0.1 to 1: 2; further, to the latter mixture is added a lubricating agent in a weight ratio of 0.1 to 0.5. The total amount of these three is made less than 3.5% of the uranium-oxide powder. Then, the whole is molded by pressing and then sintered. (NSA of Japan)

19508 METHOD FOR PRODUCING NUCLEAR FUEL GRANULAR MATERIAL. Masakino, Soji (to Hitachi Ltd.). Japanese Patent 1967-7439. Mar. 25, 1967. Filed Sept. 30, 1963.

In the method proposed, the process of mixing molding agents and UO_2 powder is simplified; and the product granular material is a homogeneous one and has good characteristics for sintering. The nuclear bonding agent and the nuclear lubricating agent, of different solvents, are admixed, using an emulsifying agent. To this admixture is added UO_2, which is then dried. (NSA of Japan)

Properties Evaluations

Refer also to abstracts 19039, 19570, and 19577.

19509 (AERE-R-5436) NATURAL CONVECTIVE BOILING OF THE ALKALI METALS: A CRITICAL REVIEW. Collier, J. G.; Kosky, P. G. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1967. 74p. Dep. CFSTI. UK 11s. 0d.

A knowledge of the characteristics of boiling liquid metals is of considerable importance in determining the performance of advanced nuclear power reactors. Considerable differences have been found to exist in the boiling heat transfer characteristics of sodium and potassium when compared to the behaviour of a normal fluid such as water. For example, the critical heat fluxes for sodium and potassium for pool boiling predicted by the hydrodynamic theories of Kutateladze and Zuber are nearly an order of magnitude lower than the experimental values at atmospheric and sub-atmospheric pressures. The basic aspects of boiling in relation to the alkali metals are considered. Topics covered include nucleation theory in pool and forced convection systems, nucleation stability, bubble growth, and bubble detachment cycles. In addition, the macroscopic aspects of natural convection, nucleation pool boiling, and film boiling are treated. Simple equations based on the thermo-physical properties of the alkali metals are recommended for the prediction of these overall properties. 90 references. (auth)

19510 (AGN-8246) EVALUATION STUDY OF HASTELLOY X AS A NUCLEAR CLADDING. Quarterly Progress Report, July 1–September 30, 1967. (Aerojet-General Corp., San Ramon, Calif. Nuclear Products and Services Group). Nov. 1967. Contract AT(04-3)-368. 50p. Dep. CFSTI.

Microconstituents were extracted from specimens of as-received low-cobalt Hastelloy X tubing and commercial-cobalt Hastelloy X sheet material. The x-ray diffraction analyses of the residues identified a high and a low parameter M_6C-type carbide in both materials. A similar evaluation of specimens of commercial-cobalt sheet material which had been aged for 2680 hr in inert gas at 1300°F revealed that both of the M_6C-type carbides exist after aging at relatively low temperature, along with sigma and mu phase. Electron microprobe analyses were performed on samples of low- and commercial-cobalt Hastelloy X tubing which had been exposed in air at 1900 and 2000°F to identify localized changes in the chemical composition of the carbide precipitates, oxide layers and matrix of the alloy. The most significant result was the determination that the Mn-rich outer oxide layer exists on samples aged at temperatures up to 2000°F. The thermogravimetric tests of specimens of four heats of Hastelloy X were terminated by equipment failure after 3400 hr of exposure. The assembly of the apparatus for the performance of tensile creep tests in argon was completed and the system was checked out. Tests of two specimens were initiated but the work was interrupted almost immediately by failure of four cooling water lines. The centrifugal creep testing of specimens from three heats of Hastelloy X at 1300°F in argon was terminated after completion of the scheduled 3000 hr of uninterrupted testing. The data were reduced and analyzed. Comparison of the data showed one heat (low cobalt E-9505) consistently displayed superior strength properties than the other two heats (commercial cobalt X5-4793, X5-4904 vacuum melted). Based upon these data vacuum melting does not appear to significantly affect the creep properties of Hastelloy X. The design of centrifugal creep specimens for testing at 1400°F in argon was completed and fabrication of these test specimens is in progress. (J.C.W.)

19511 (BNWL-455, Paper 7.1-6) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Beeston, J. M.; Brinkman, C. R.; Zelezny, W. F. (Idaho Nuclear Corp., Idaho Falls).

A program for the determination of the effect of hydrogen on the embrittlement of reactor pressure vessel steels is discussed. Type A542 steel was subjected to several heat treatments and the results are noted. Work is continuing on a study of fractures in welded sections of pressure vessels. (L.C.L.)

19512 (BNWL-455, Paper 8.1-6) DEVELOPMENT OF TEST PROCEDURES: FRACTURE TOUGHNESS OF REACTOR PRESSURE VESSEL STEELS. Ripling, E. J.; Crosley, Phillip (Materials Research Lab., Inc., Glenwood, Ill.).

Test procedures were developed for obtaining plane strain fracture toughness data on irradiated reactor pressure vessel steels. A closed-loop servo-hydraulic testing machine was used initially to obtain data on load-to-fracture times down to 10 msec. To obtain more rapid loading times, a drop weight test was developed. Phototraces of results of both types of tests on A 302-B steel specimens are presented. It is tentatively concluded that rapid loading rate promotes plane strain fracture in this mild steel. (L.C.L.)

19513 (BNWL-SA-1623) HIGH POWER DENSITY FUEL STUDIES IN PRTR. Freshley, M. D.; Goldsmith, Stanley (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 29, 1968. Contract AT(45-1)-1830. 21p. (CONF-680105-1). Dep. CFSTI.

From Industry Meeting on Water Reactor Fuel Element Technology, Germantown, Md.

UO_2–PuO_2 powder and pellet thermal reactor fuels are performing well under high power density conditions. No problems have been encountered with maximum fuel temperatures near melting. The present peak burnup of high power density elements in the Batch Core is approximately 6400 MWd/tonne. Higher peak burnups are aimed for, and studies of the defect behavior under these operating conditions continues. Data indicate that actual measured internal gas pressures in oxide fuel rods undergoing irradiation at high specific powers are less than the maximum pressures expected. A new fuel concept of using nonsintered mixed-oxide pellet fuel in thermal power reactors is being investigated. A prototype 7-rod cluster element of nonsintered UO_2–PuO_2 pellet fuel was exposed to a burnup of 600 MWd/tonne. The rods were examined nondestructively by autoradiography and gamma scanning. Results are encouraging. (J.C.W.)

19514 (CEA-R-3187) ETUDE DES MECANISMES ELEMENTAIRES DE DEFORMATION PAR FLUAGE DE L'URANIUM EN FONCTION DE LA TEMPERATURE (DE 150° A 760° C) PAR LA MESURE DES ENERGIES D'ACTIVATION. (Study of Elementary Mechanisms of Creep in U as a Function of Temperature (150° to 760°C) by Activation Energy Measurements). Grenier, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 79p. (In French). Dep. Thesis. Submitted to Univ., Paris.

Creep tests were carried out on single crystals and polycrystalline specimens of uranium in both the α and β phases at 150 to 760°C. The determination of the activation energy for creep and the study of its variation with temperature made it possible to distinguish various temperature ranges in which one or more elementary mechanisms govern deformation. Micrographic observations after creep and the study of the variation of creep-rate with load support the conclusions. The creep behavior of single crystals is identical with that of polycrystalline material below 325°C. From 325°C to one upper limiting temperature whose value depends on the purity and previous history of the metal, the creep deformation of uranium is controlled by cross-slip. From this limiting temperature up to 520°C, the creep of uranium involves two independent mechanisms operating simultaneously, the movement of screw dislocation by cross-slip and the climbing of edge dislocations out of their slip plane. Between 520°C and the α–β transformation temperature creep in polycrystals is governed by the climb of edge dislocations out of their slip planes, by a pile up mechanism in the case of primary creep and by dipole annihilation in the case of secondary creep. In single crystals creep is dependent on the climb of edge dislocations into pre-existent subboundaries and their subsequent rearrangement within these boundaries. In the β phase the creep of polycrystals is governed by the diffusional climb of edge dislocations. Between 450 and 630°C small alloy additions of molybdenum modify the creep characteristics of uranium although the deformation mechanisms involved are analogous to those in the pure metal. (auth)

19515 (GEMP-678) ENTHALPY MEASUREMENTS OF UO_2 AND TUNGSTEN TO 3260°K. Hein, R. A.; Flagella, P. N. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Feb. 16, 1968. Contract AT(40-1)-2847. 21p. (CONF-680408-1). Dep. CFSTI.

From 70th Annual Meeting of the American Ceramic Society, Chicago, Ill.

Enthalpy data are reported for UO_2 at 1200 to 3260°K. In these measurements, stoichiometric (O/U = 2.003 ± 0.003) UO_2 was sealed in evacuated tungsten capsules and heated in a hydrogen atmosphere furnace. A drop technique was employed in conjunction with an adiabatic water calorimeter to measure the heat releases which were then converted to enthalpies. A discontinuity in the enthalpy-temperature curve at 3115°K was used to calculate the heat of fusion as 18.2 ± 0.5 kcal/mole. Prior to these tests similar measurements were made of the enthalpy of tungsten to 3250°K. These results were found to be in excellent agreement with existing high-temperature data for this material and hence the accuracy of the technique used seems to be well established. A comparison is made between the current data and previously reported values for both the enthalpy and heat of fusion of UO_2. (auth)

19516 (LA-3850) THE SOLUBILITIES OF SELECTED ELEMENTS IN LIQUID PLUTONIUM. XII. CHROMIUM. Bower-

sox, D. F. (Los Alamos Scientific Lab., N. Mex.). Dec. 21, 1967. Contract W-7405-eng-36. 5p. Dep. CFSTI.

The reversibility of the Cr-Pu system was demonstrated at low Cr concentrations. The solubility increased from 0.36 wt % Cr at 700°C to 2.00 wt % Cr at 1000°C. The data fit the equation $\log N_{Cr} = 1.32 - 3.03 \times 10^3 T^{-1}$, where N_{Cr} is the mole fraction of Cr in a saturated solution at absolute temperature T. (auth)

19517 (NASA-SP-5085) ADHESIVE BONDING OF STAINLESS STEELS: INCLUDING PRECIPITATION-HARDENING STAINLESS STEELS. Keith, R. E.; Randall, M. D.; Martin, D. C. (Battelle Memorial Inst., Columbus, Ohio). [Feb. 16, 1967]. Contract DA-01-021-AMC-11651(Z). 125p. Dep. CFSTI.

The state of the art of adhesive bonding of stainless steels is reported. Typical joint designs, surface preparation procedures, and environmental factors are described as they influence choice among the available adhesives and processing techniques. Both organic and inorganic adhesives are covered. (auth)

19518 (ORNL-RMIC-7) BIBLIOGRAPHY OF MAGNETIC MATERIALS AND TABULATION OF MAGNETIC TRANSITION TEMPERATURES. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 62p. Dep. CFSTI.

Materials are indexed by chemical formula in two lists, ferromagnetic and antiferromagnetic materials. The upper transition temperature (the Curie or Néel temperature) is given and a reference number from the bibliography. A listing of 915 references is presented. (J.C.W.)

19519 (ORNL-RMIC-8) GROUPS IV, V, AND VI TRANSITION METALS. SUPPLEMENT NO. 1, SELECTED REFERENCES ON PREPARATION, STRUCTURE, PHYSICAL PROPERTIES, METALLOGRAPHY, AND TRANSPORT PROPERTIES. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 27p. Dep. CFSTI.

A general bibliography for preparation methods, crystal structure, transport properties, and physical and mechanical properties is given for transition metals. A bibliography is also given for each of Groups IV, V, and VI for preparation methods, crystal structure, transport properties, and physical and mechanical properties. (J.C.W.)

19520 (RISO-151) METALLURGY DEPARTMENT ANNUAL PROGRESS REPORT FOR THE PERIOD ENDING MARCH 31, 1967. (Danish Atomic Energy Commission, Risoe. Research Establishment). July 1967. 42p. Dep.

Developments are reported for studies on: UO_2–Zircaloy fuel elements for water reactors; mechanical testing and metallography of Zircaloy-2; artificial hydriding of Zircaloy-2; dispersion-strengthened zirconium alloys; glove box with high-purity argon atmosphere; corrosion testing of Zircaloy-2; Zircaloy-4 and a zirconium–chromium–iron alloy; corrosion of stainless steel in boiling, concentrated seawater; mechanical properties in relation to structure of Al–Al_2O_3; effect of the shape of a second phase on the strength properties of a two-phase alloy; rolling textures in fcc metals and alloys; dislocation densities in pure Al; irradiation effects on SAP; irradiations of pressure vessel steels; post irradiation effects on SAP; post irradiation examination of vibratory-compacted and pellet-filled UO_2 fuel pins as well as MTR fuel elements; fabrication of UO_2–Zircaloy fuel elements and MTR fuel elements; D_2O-loop boiling experiment; creep properties of Al–Al_2O_3; homogenized Al–Al_2O_3; micronizing and air separation of powder; preparation of UO_2 pellets and post irradiation examination of UO_2 pellets. (Denmark)

19521 (UCID-15269) LIQUID AND VAPOR DENSITIES AND CRITICAL TEMPERATURES FOR THE ALKALI METALS. Krikorian, O. H. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 4, 1966. Contract W-7405-eng-48. 16p. Dep. CFSTI.

Literature pertaining to the liquid and vapor densities and critical temperatures of alkali metals for space power systems is reviewed and discussed. Subjects considered include density relationships at the critical point, principle of corresponding states, Kordes relationship, and treatment of data. Data on liquid and vapor densities of Cs, K, Na, and Rb are summarized in diagrams as is the Kordes function plot for Cs, Hg, K, Li, Na, and Rb. Critical temperatures, densities, and a comparison of calculated versus observed liquid and vapor densities of these metals are shown in tables. 18 references. (P.G.C.)

19522 (UCID-15271) THERMODYNAMIC PROPERTIES OF SODIUM AND POTASSIUM. Oldham, J. L. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 2, 1967. Contract W-7405-eng-48. 53p. Dep. CFSTI.

Mollier diagrams were developed for K and Na at 0.1 to 100 atm and temperatures to 2500°K. Four techniques were used to determine the thermodynamic properties: virial, equation of state, corresponding states, and quasichemical analysis. A computer code was developed to calculate enthalpy, entropy, specific heat, and PVT values of Ce, K, and Na. Input constants for the properties code are given which compute enthalpy, entropy, specific volume, molecular weight, specific heat, and molecular composition. (P.G.C.)

19523 (NSJ-tr-94) STRESS IN THE OXIDE FILMS OF ZIRCONIUM AND ZIRCALOY-2 DURING ANODIC OXIDATION. Nomura, Sueo; Akutsu, Cho; Saruyama, Ichiro. Translated for Japan Atomic Energy Research Inst., Tokyo, from Denki Kagaku, 33: 723-7(1965). 16p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

This paper was abstracted from the original language and appeared in NSA as 21: 11230.

19524 (UCRL-Trans-10219) REACTIONS OF COLUMBIUM AND VANADIUM WITH MAGNESIUM. Savitskii, E. M.; Baron, V. V.; Efimov, Yu. V.; Bykova, M. I. Translated by Z. F. St-Gallay for Univ. of California Lawrence Radiation Lab., Livermore, from Tr. Inst. Met. im. A. A. Baikova, Akad. Nauk SSSR, No. 14, 139-46(1963). 8p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The solubility of Nb and V in liquid Mg was determined by the method of isothermal aging and subsequent quenching. It was found that Nb and V did not dissolve in solid Mg but that as liquid Mg was heated at 660 to 950°C, the solubility of V increased from 0.06 to 0.3%. At 1200°C the solubility of Nb in Mg was 0.05%. On remelting with Mg, Nb and V were deoxidized, and hardness, microhardness, and tensile strength decreased while plasticity increased. However, V was not completely free from O_2 after remelting with Mg six times. Phase diagrams for the Mg–Nb and Mg–V systems, based on x-ray and thermal studies of macrostructure and microstructure, and on hardness changes in the alloys are shown. The nature of the liquidus curve and the position of the solidus curve on the Mg sides of the system point to a pseudo-eutectic melting pattern. (P.G.C.)

19525 (WAPT-Trans-86) DETERMINATION OF THE SOLUBILITY AND DIFFUSION COEFFICIENT OF HYDROGEN IN ZIRCONIUM. Someno, Mayumi. Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from Nippon Kinzoku Gakkaishi, 24: 249-53(1960). 16p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The solubility of H in Zr was determined using absorption isotherms, and the diffusion coefficients of H in alpha and beta Zr were determined by the method of diffusion annealing. Methods of sample preparation, equipment and procedures used in the investigation are described and discussed. Absorption isothermals for H at 500 to 950°C are shown, as are curves indicating solubility of H in alpha and beta Zr, and equations for determination of the diffusion coefficients. (P.G.C.)

19526 ZIRCALOY-2 (NUCLEAR REACTOR ALLOY). Alloy Dig., Zr-3, 1-2(July 1967).

A Zr alloy containing 1.2 to 1.7% Sn, 0.07 to 0.2% Fe, 0.05 to 0.15% Cr and 0.03 to 0.08% Ni is recommended as a structural material for heat transfer in nuclear reactors at temperature up to 750°F. Mechanical and physical properties, heat treatment, machinability, weldability, workability, corrosion resistance, grinding, and pickling characteristics of Zircaloy 2 are given. (Rev. Met. Lit.)

19527 EFFECT OF RARE EARTH METALS ON THE GAS SATURATION OF STEEL. Skok, Yu. Ya.; Braun, M. P.; Kostyrko, O. S.; Kondrashev, A. I.; Neshenko, N. S.; Khmelevskaya, A. F. Tekhnol. Organ. Proizvod., No. 1, 41-2(1967). (In Russian).

Rare earth metals were added to molten steel after complete reduction to determine their effect on gas saturation. Samples were removed 2 to 3 minutes after introducing the additives and quenched in water. Hydrogen concentration was determined by the vacuum-heating method, oxygen and nitrogen concentrations were determined by the vacuum-melting method. It was found that the addition of cerium in quantities of 0.2 to 0.3% results in a considerable reduction in gas concentration with a gradual increase in the gas saturation of the steel as cerium is added beyond this point. Similar behavior was observed with the introduction of lanthanum and neodymium. Thermodynamic calculation of the reduction process using rare earth metals shows that these elements are strong reducing agents which have a deoxidizing capacity far exceeding that of aluminum. Hydrogen concentration remains practically unchanged by the introduction of rare earth metals, or may increase slightly due to the change in the solubility of this gas in molten steel containing rare earth metals. However, treatment of large ingots of structural steel with misch metal results in a considerable reduction of free hydrogen, which

is of considerable practical significance from the standpoint of reducing the flocculation of steel. Oxygen concentration is also considerably reduced in this case with only a slight reduction in nitrogen. Reduction in hydrogen concentration is considerably dependent on the amount of misch metal introduced and on the degree of previous reduction of the steel. (ATD)

19528 MODERATOR MATERIALS ON THE BASIS OF HYDROGEN CONTAINING TRANSITION METAL COMPOUNDS. Goretzki, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Atomkernenergie, 13: 111-15(1968). (In German).

The power to weight ratio of a thermal reactor is mainly determined by the slowing-down rate of the moderator. The path necessary to slow down the fission neutrons is a factor of the critical size of the reactor. For non-stationary power reactors, moderator materials with high hydrogen content and thermal stability are adequate. The binary and ternary hydrogen compounds of the transition metals are discussed with respect of the applicability as moderator. (auth)

19529 SPECIFIC HEATS OF α-PLUTONIUM AND α-MANGANESE. Taylor, J. C.; Linford, P. F. T. Cryogenics, 7: 305(Oct. 1967).

Basic similarities of electrical resistivity were found between α-plutonium and α-manganese, but examination of the published data on the low temperature specific heats of the two elements revealed no close similarity. (UK)

19530 ROLE OF NIOBIUM IN THE IMPROVEMENT OF THE MECHANICAL PROPERTIES OF WELDABLE CONSTRUCTION STEELS. I. Mandry, Pierre Metaux (Corros.-Ind.), 42: 389-411(Nov. 1967). (In French).

A brief bibliographic review is given of the known effects of niobium on construction steels and of the most recent hypotheses advanced to explain these effects. The materials used in the experimental study and the experimental methods are described in detail. Mechanical tests, thermal and dilatometric analyses, optical and electronic microscopy, electrolytic extractions, radiocrystallographic analyses, and chemical analyses were the methods used for the study of the role of Nb in the improvement of the mechanical properties of construction steels. Results are reported on the effects of Nb on the principal structural states. The most important of these are that after austenitization at low temperature, followed by air cooling, the presence of low quantities of Nb is shown in the form of Nb precipitates which provoke a significant refinement of the ferritic grain. After high temperature austenitization, followed by air cooling, the addition of Nb causes an appreciable hardening of the ferrite. (J.S.R.)

19531 PROPERTIES AND MICROSTRUCTURE OF SPRAY-QUENCHED THICK-SECTION STEELS. Strunck, S. S.; Pense, A. W.; Stout, R. D. (Lehigh Univ., Bethlehem, Pa.). Weld. Res. Counc. Bull., No. 120, 1-15(Feb. 1967).

With the increasing use of thick-section quenched and tempered steels for nuclear and chemical reactors, there is a definite need for information on the properties of some of the newer low-alloy high-strength steels when given such thick-section heat treatment. Of particular interest are yield and tensile strengths attainable, the notch toughness to be expected, the plastic fatigue strengths available and the kinds of microstructure that appear to be characteristic of these thicknesses. In the program reported, four quenched and tempered heavy-section steels—A212 Grade B, A533 Grade B, A542 and A543—were studied in the simulated 6-in. thick and 12-in. thick quenched, tempered and stress-relieved condition. Specimens taken from these simulated heavy sections were evaluated to provide a characterization of the properties and structure of heavy-section, heat-treated, low-alloy steels. The results show that increasing the section size from 6 to 12 in. produced no important changes in strength, notch toughness or fatigue resistance in these steels in the quenched, tempered and stress-relieved condition. When comparing 1-in. thick plate with the heavy sections, strength decreased only modestly while notch toughness decreased substantially. Because of their initial good toughness, however, the alloy steels still exhibited transition temperatures below −10°F. The fatigue and elevated temperature properties of the steels were similar to those found in thinner sections of equivalent tensile strength. The results of the microstructure study confirmed the mechanical property tests in that little difference in microstructure was observed between the 6-in. and 12-in. conditions. (auth)

19532 HIGH-TEMPERATURE FATIGUE OF CHROME STEELS. Lascu-Simion, L. Cercet. Met., 8: 357-65(1966). (In Rumanian).

The results of fatigue rotary bending tests carried out at high temperatures on two chromium alloy steels are reported. The effect of prolonged high temperatures on the static and fatigue characteristics of a 1/Cr and 0.5% Mo alloy steel is then analyzed. (Rom. Sci. Abstr.)

19533 INVESTIGATION OF THE SOLUBILITY OF NITROGEN IN MELTS OF NICKEL WITH CERIUM. Ivanov, E. G.; Stomakhin, A. Ya.; Medvedeva, G. M.; Filippov, A. F. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Chern. Met., No. 5, 69-72(1966). (In Russian).

The investigation was performed with the aid of the experimental setup used by A. Ya. Stomakhin (Candidate degree dissertation, Moscow Institute of Steel and Alloys, 1965). Six discrete melts of Ce-treated Ni (refined electrolytic Ni at least 99.987% pure, alloyed with 99.2% pure Ce) were melted at 1550°C (1823°K) in identical CeO_2 crucibles (used in order to reduce to a minimum the interaction between the Ce of the metal and the crucible). The time needed for the equilibrium to set in (10 to 20 min) was longer the higher the Ce content of the alloy was. All the six melts were brought under the same temperature and pressure (298°K, 760 mm Hg) in order to assure the reproducibility of findings and subjected to tests for determining the solubility of nitrogen in these melts by the method described in Stomakhin's work. (ATD)

19534 DETERMINATION OF HYDROGEN IN METALS WITH HIGH SORPTION CAPACITY. Orlova, N. M.; Petrov, A. A. Vestn. Leningrad. Univ., Ser. Fiz. Khim., No. 10, 55-63(May 1967). (In Russian).

The peculiarities and working conditions of the determination of hydrogen in Ti, Zi, Pd, V, Pr, Nd, Y by spectral-isotopic method have been shown. (tr-auth)

19535 SUPERCONDUCTING PROPERTIES AND PHASE TRANSFORMATION IN TITANIUM ALLOYS. III. ADDITIONS OF IRON AND NIOBIUM. Nishimura, Takashi; Zwicker, Ulrich (Univ., Erlangen-Nuernberg, Ger.). Z. Metallk., 59: 69-73 (Jan. 1968). (In German).

Investigations on titanium-alloys with additions of iron and niobium have shown, that there is a mutual influence of both elements. The expected decrease of transition temperature of samples containing iron at 400 and 500°C-annealing was found. Ternary alloys with high iron- and low niobium-content show a decrease and alloys with high niobium- and low iron-content an increase of T_c. The negative temperature coefficient of the binary alloys also occurs with ternary alloys. (auth)

19536 HIGH-TEMPERATURE SOLUBILITY OF NITROGEN IN MOLYBDENUM. Fromm, E.; Jehn, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Less-Common Metals, 14: 474-5(Apr. 1968). (In German).

The effects of pressure and temperature on the solubility of nitrogen in molybdenum were studied. Data are presented in a graph. Nitrogen concentration can be expressed by the following relation: $C_N = VPN_2 \times 4.39 \times 10^2 \exp(-22600/RT)$ with C_N in ppM, p in Torr, and T in °K. The heat of solution, $\Delta H = +45.2$ kcal/mol N_2. (M.C.G.)

19537 TRANSFORMATION KINETICS OF U/10 wt PERCENT Pu/10 wt PERCENT Fz ALLOY. Savage, H. (Argonne National Lab., Ill.). J. Nucl. Mater., 25: 241-8(1968).

Time-temperature-transformation characteristics of the alloy U/10wt%Pu/10wt% fizzium were determined. The variation of phase-sensitive properties with heat treatment was used to follow the transformation. Changes in the metallographic structure, hardness, length, and elastic modulus were followed during transformation anneals at 400 to 550°C. The transformation was found to proceed within one minute from the start of annealing and to end after about 30 min at 450°C. A discussion of the transformation kinetics of similar alloys is included. (auth)

19538 HEAT CONTENT AND SPECIFIC HEAT OF SOME METALLIC FAST-REACTOR FUELS CONTAINING PLUTONIUM. Savage, H. (Argonne National Lab., Ill.). J. Nucl. Mater., 25: 249-59(1968).

The heat contents of U/10Pu, U/10Pu/10Fz, U/15Pu/15Zr and U/15Pu/6Ti(wt %) were measured in a drop calorimeter to about 1200°C. Up to about 1000°C the heat contents per Avogadro's number of atoms of alloy are nearly the same as for unalloyed uranium in all the alloys except U/15Pu/10Zr, which has a 10% lower heat content in the γ temperature range. The alloys differ from one another in the details of heat evolution in the neighborhood of the phase transformations. The heat of fusion drops from 2.9 kcal/g · atom in unalloyed uranium to 2.4 kcal/g · atom in U/10Pu and to 2.0 kcal/g · atom in U/10Pu/10Fz. (auth)

19539 MAGNETIZATION OF THIN, CYLINDRICAL COBALT AND PERMALLOY LAYERS SUBJECTED TO TWO MAGNETIC FIELDS, INCLUDING A CIRCULAR, ALTERNATING, AND A LONGITUDINAL, STATIC ONE. Procopiu, St.; Viscrian, I.;

Naum, C.; Calugaru, Gh. (Physical Research Center, Iasi). Stud. Cercet. Fiz., 19: 1049-53(1967). (In Rumanian).

The Procopiu effect, discovered in 1930, was further investigated, using electrodeposited layers of cobalt and Permalloy-60 on 4-cm long, 1-mm diameter copper wires. A portion of the longitudinally rolled and scratched cylinders was vacuum-annealed at 800 to 900°C, in order to create large crystallites with disordered orientation in the support. The specimens were placed coaxially with the coils of the measuring apparatus which included Helmholtz coils to create the static, longitudinal field. The measurements were carried out in alternating circular magnetic fields with maximum intensities of 66 and 22 oersted for the cobalt and Permalloy, respectively. By means of the crossed-field method, it was possible to determine the coercive field of the layer. For low-intensity longitudinal fields, in the direction perpendicular to the generatrix, the coercive force was found to be equal to the circular field changing the sign of the induced electromotive force. Cobalt layers deposited on the longitudinally scratched and rolled specimens exhibited lower coercive forces in both direction than the layers on annealed supports; the maximum permeability was also higher. For Permalloy layers, the transversal coercive field was smaller and was also independent of the pretreatment of the support. (TTT)

19540 THE RESISTIVITY OF TANTALUM–TUNGSTEN ALLOYS BETWEEN 300 AND 2400°K. Thomas, Ludwig (Westinghouse Electric Corp., Pittsburgh). Z. Metallk., 59: 127-9 Feb. 1968). (In German).

The electrical resistivity of Ta-W alloys was measured at 300 to 2400°K. The resistivity is not proportional to the temperature. The deviations change continuously from the tantalum- to tungsten-value. (tr-auth)

19541 INVESTIGATIONS ON THE RESIDUAL RESISTIVITY OF TUNGSTEN WITH VARYING CARBON CONTENT. Krautz, Erich; Kuhlmann, Hans-Heinz; Schultz, Hermann (OSRAM-Studiengesellschaft, Augsburg). Z. Metallk., 59: 133-7(Feb. 1968). (In German).

By electron zone melting tungsten single crystals have been made with high purity (ratio of residual resistance at 4.2°K to resistance at 273°K $z = \rho(4.2)/\delta(273) \leq 2 \cdot 10^{-5}$). Therefrom thin filaments (= 0.2 mm in diameter) have been produced in the usual way and then heated in CH_4 at a pressure $\approx 10^{-4}$ torr at 1200 to 2000°C in order to get carbon in higher concentration in solid solution. By rapid quenching this carbon concentration can be frozen in at room temperature. By annealing processes ($T \geq 300$°C) the abundant carbon over the thermodynamic equilibrium can be eliminated successively. Isochronic annealing shows a marked drop of z between 300 and 450°C depending on the initial amount of carbon concentration. At higher temperatures (>840°C) precipitation of small W_2C-crystallites (~0.1 μm) could be detected by electron microscope. It is therefore necessary when analyzing stage III in annealing curves to pay attention to this stage caused by carbon in solid solution. (tr-auth)

19542 USE OF ELECTROCHEMICAL SECTIONING IN THE STUDY OF DIFFUSION IN TUNGSTEN. Pawel, R. E.; Lundy, T. S. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-20. J. Electrochem. Soc., 115: 233-7(Mar. 1968). (ORNL-P-3404).

A microsectioning technique based on metal anodization and subsequent removal of the anodic oxide film was developed and tested by using it to determine the concentration profiles of ^{95}Nb in tungsten single crystals after diffusion at 1800°C. The anodization characteristics of tungsten pertinent to quantitative serial sectioning were studied and several techniques for increasing the efficiency of isotope removal during chemical dissolution of the anodic film were tried. The resulting data were highly self-consistent and demonstrate the value of the method in investigating diffusion behavior in tungsten, particularly at low temperatures. (auth)

19543 EFFECTS OF SILICIDE COATINGS ON MECHANICAL PROPERTIES OF MOLYBDENUM. Ivanov, V. E.; Nechiporenko, E. P.; Zmii, V. I.; Azhazha, V. M.; Polyakov, N. I.; Osipov, A. D. (Inst. of Physics and Tech., Kiev). Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 62-5(Jan. 1968). (In Russian).

The influence of silicide coatings on mechanical properties of molybdenum was studied at 20 to 1500°C. Higher ductility and strength at temperatures above 1000°C were observed. (R.V.J.)

19544 LANTHANUM ANTIMONIDE PHYSICAL PROPERTIES. Goncharova, E. V.; Zhukova, T. B.; Lopatina, Z. I. (Inst. of Semiconductors, Kiev). Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 44-8(Jan. 1968). (In Russian).

Physico-chemical properties of prepared lanthanum antimonide crystals were studied at room temperature. Temperature dependence of the specific electric conductivity and differential thermal emf of LaSb at 100 to 1200°K and the Hall effect at 100 to 500°K were investigated. (R.V.J.)

19545 HIGH TEMPERATURE BRAZING ALLOYS FOR TUNGSTEN AND TANTALUM AND ALLOYS THEREOF. Marshall, J. C. (to United States Atomic Energy Commission). U. S. Patent 3,374,092. Mar. 19, 1968.

A ternary brazing alloy for joining a refractory metal selected from tungsten, tantalum, and alloys is described. The alloy contains 10 to 35 wt % ruthenium, 45 to 90 wt % tungsten, and the remainder rhenium. The brazing alloy has a melting point in the range 2300 to 2800°C. (AEC)

19546 EFFECT OF SUBSTITUTIONAL ALLOYING ELEMENTS ON THE ELEVATED TEMPERATURE MECHANICAL PROPERTIES OF ALPHA IRON. deBarbadillo II, John Joseph. Bethlehem, Pa., Lehigh Univ., 1967. 115p.

Thesis.

The elevated temperature mechanical properties of alloys of alpha iron containing 1.5 atomic percent nickel, silicon, manganese, chromium, or molybdenum in solution have been investigated. Constant and differential strain rate tensile tests as well as constant load and constant stress creep tests were used in this analysis. Optical and electron microscopy were employed to correlate microstructural features with mechanical behavior. It was established that the principal role of substitutional alloying elements is to retard dynamic recovery processes which otherwise rapidly diminish the flow stress of alpha iron above 600°F. The magnitude of this effect is related to the strength of interaction between substitutional solutes and residual interstitial elements. In this respect nickel and silicon were found to contribute little to the creep resistance of iron above 600°F while manganese, chromium, and molybdenum in order of increasing effectiveness retard recovery, thereby increasing the creep strength. In iron-molybdenum alloys an actual secondary peak of flow stress occurs at 1000 to 1200°F. A chemical interaction between the substitutional alloying element and interstitial carbon or nitrogen atoms bound to dislocations is apparently responsible for the observed strengthening. In iron-chromium and iron-molybdenum alloys precipitation of carbides at subgrain boundaries and deformation bands coincide with transitions in creep rate leading to lowered creep resistance. Little difference was noted between the recovery behavior of alloys containing 0.005 percent carbon and 0.10 percent carbon. A reduction of dissolved carbon by a wet hydrogen anneal resulted in a substantial reduction in strength of the iron-chromium and iron-molybdenum alloys. Chromium by itself was found to have practically no effect on the strength and recovery of iron although molybdenum in decarburized iron is capable of strengthening by a strain-aging mechanism at 1000°F. The progress of the recovery process as reflected in the decline of tensile and creep strength could be followed through the development of a substructure. Metallographic and mechanical test results showed that in chromium and molybdenum bearing alloys, once recovery is initiated it tends to occur more rapidly giving the appearance of compressing the temperature range of recovery. (Disser. Abstr.)

Structure and Phase Studies

19547 (CISE-E-581) RECRYSTALLIZATION IN COLD ROLLED ZIRCALOY-2. Bassi, A.; Camona, G.; Paganini, L. (Centro Informazioni Studi Esperienze, Milan (Italy)). [1965]. 4p. (CONF-651092-1).

From 5th Italian Conference on Electron Microscopy, Bologna, Italy.

Recrystallization phenomena occurring in Zircaloy-2, under conditions approximating normal heat treatments, were studied by electron microscopy. Recrystallization of thin-rolled sheets was effected by heat treatments at 550, 600, 650, and 750°C, during periods of 5 min, 30 min, 1 hr, and 2 hr, followed by quenching. At 550°C nucleation of new grains appeared only after 30 min, while at 750°C the material appeared to be completely recrystallized after 5 min. (P.G.C.)

19548 (UCRL-Trans-10227) EFFECT OF THE FORM OF FERRITE ON THE RECRYSTALLIZATION OF STEEL IN FRACTURES. Lipchin, N. N.; Belykh, Yu. A.; Gromov, B. V. Translated by M. Tremberth for Univ. of California Lawrence Radiation Lab., Livermore, from Izv. Vyssh. Ucheb. Zabed., Chern. Met., 8: 141-4(1966). 8p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Recrystallization of steels in the original annealed condition is affected by the form in which the excess phase is precipitated. Oriented precipitation of ferrite (carbide) complicated the formation of a new grain complex. The temperature of recrystallization in fracture of steels with anomalous annealed structure is not connected with the temperature of the critical point Ac_3. The

reheating temperature from which grain refinement in the fracture of steel with acicular ferrite is ensured depends on the rate of heating and on the stability of the carbide particles. (auth)

19549 (UCRL-Trans-10228) EFFECTS OF THERMAL PRETREATMENT AND ALUMINUM NITRIDE ON THE AUSTENITE GRAIN SIZE. Bezdek, Ladislav. Translated by Z. F. St-Gallay for Univ. of California Lawrence Radiation Lab., Livermore, from Kovove Mater., 4: 143-55(1966). 24p. Dep. CFSTI, JCL $2.60 fs, $1.10 mf.

The thermal treatment of carbon steel deoxidized with 0.05% of aluminum exerts a considerable effect on the growth of austenite grains at the austenitizing temperature of 950°C. The austenite grains are the largest after the thermal pretreatment 1150/1h-water (or air or furnace), while they are the smallest after the pretreatment 1175 to 1300/1h-water (or air or furnace). This cannot be explained by the effect of the initial structure upon the formation and the growth of the austenite nuclei; the explanation lies instead in the influence of the thermal pretreatment on the dissolution and the agglomeration of aluminum nitride. The result of a thermal pretreatment in which AlN dissolves to a substantial extent is that, when the steel is reheated to the temperature at which AlN precipitates out, it separates out in a form that greatly suppresses the growth of the austenite grains. The temporal and thermal stability of the austenite grains (i.e., the growth of the latter) is determined not by the total amount of aluminum nitride, but by a fraction of it (active aluminum nitride) that efficiently inhibits the growth of austenite grains. (auth)

19550 PHASE EQUILIBRIA IN Zr–Nb–V SYSTEM. Raevskaya, M. V.; Sokolova, I. G.; Sokolovskaya, E. M.; Ronami, G. N.; Kuznetsova, S. M.; Aleshina, V. A. Vestn. Mosk. Univ., Ser. II, Khim., No. 1, 64-6(Jan.-Feb. 1968). (In Russian).

Alloys of the Zr–Nb–V system were studied. Isothermal sections at 1000, 700, and 500°C were plotted. (auth)

19551 X-RAY STRUCTURAL STUDIES OF TERNARY Zr–Mo–B AND Zr–Ta–B SYSTEMS. Voroshilov, Yu. V.; Kuz'ma, Yu. B. (Lvov State Univ.). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met., No. 4, 145-8(1967). (In Russian).

X-ray structural analyses of ternary Zr–Mo–B and Zr–Ta–B systems revealed the presence of continuous solid solutions between zirconium diboride and molybdenum and tantalum diborides at 2600° and 3000°C, respectively. The phase x-ray analysis also confirmed the existence of binary borides stable at 1500°C. Tabulated data are given on binary compounds of Zr–B, Zr–Mo, Mo–B, Ta–B systems. The presence of $ZrMo_2$ with crystalline structure of $MgCu_2$ (a = 7.587 Å) type was found. Ternary compounds in the Zr–Mo–B and Zr–Ta–B systems were not observed. A double-phase region without any inter-diffusion was found between ZrB_2 and Mo_2B_5 at 1500°C. (R.V.J.)

19552 ELECTRON MICROSCOPIC STUDY OF THE STRUCTURE OF Zr–4 PERCENT Nb ALLOY. Sudareva, S. V.; Buinov, N. N. (Inst. of the Physics of Metals, Moscow). Fiz. Metal. Metalloved., 24: 179-81(1967). (In Russian).

An electron microscopic study of Zr–Nb (4 wt %) alloy showed that in some recrystallized grains of the alloy after 93% straining and subsequent tempering at 550°C for 2 hr, in addition to particles revealed by diffraction contrast, formations were found which show contrast in the form of two dark segments with a line of zero intensity between them. The nature of these formations and certain questions of the crystallography of the precipitating phase are discussed. The arrangement of neighboring atoms in the (110) plane of beta-Nb phase and in the (0001) plane of Zr is shown. The particles of the homogeneously precipitating beta-Nb phase should take the form of fine, elongated platelets, drawn in the [1120] direction. Inasmuch as in the (0001) matrix plane there exist three such directions, elongated platelets of three orientations, 60° apart, are possible. An electron micrograph of the alloy after oil quenching at 1000°C and tempering at 550°C for 62 hr, shows that a Widmanstatten structure of such particles is observed inside the martensitic needles. (ATD)

19553 SINGLE CRYSTALLINE ELASTIC CONSTANTS OF LEAD–THALLIUM ALLOYS. Shepard, M. L.; Smith, J. F. (Ames. Lab., Iowa). Contract W-7405-eng-42. Acta Met., 15: 357-63(Feb. 1967). (IS-1332).

The adiabatic elastic constants of seven fcc lead–thallium alloy single crystals have been measured by the ultrasonic pulse-echo technique over the composition range 5 to 72 at. % thallium and at 4.2 to 300°K. The room temperature values of the elastic constants C_{11}, $\frac{1}{2}(C_{11}-C_{12})$, and C_{44} have been combined with the room temperature values of the fcc indium–thallium elastic constants to derive by interpolation the constants for the metastable fcc allotrope of thallium: $C_{11} = 4.08 \times 10^{11}$ dyn/cm^2, $C_{12} = 3.40 \times 10^{11}$ dyn/cm^2, and $C_{44} = 3.40 \times 10^{11}$ dyn/cm^2. The composition dependence of the shear anisotropy shows an extremum near 60 at. % thallium. If a rigid band approximation is applied, this extremum can be correlated with the band structure of pure lead. (auth)

19554 PRECIPITATION OF NITRIDE IN NIOBIUM (COLUMBIUM) AND NIOBIUM–ZIRCONIUM ALLOYS. de Lamotte, E.; Huang, Y.; Altstetter, C. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. Trans. Met. Soc. AIME, 239: 1625-30(Oct. 1967). (COO-1198-463).

Nitrogen was introduced into pure niobium and dilute Nb–Zr alloy wires by equilibration with pure nitrogen gas at high temperatures. Room-temperature hardness was correlated with the alloy composition, heat treatment, and microstructure. Hardness was found to be most sensitive to the amount of nitrogen in solution; however, a significant hardening up to 500 dph took place upon aging of quenched alloys. A coarse dispersion of nitride did not significantly increase the hardness of the material though the nitride was found to have a hardness of 1400 Knoop hardness number. High-nitrogen alloys cleaved on {100} planes and had negligible ductility. Precipitation was found to occur in either a discontinuous or a continuous fashion, depending on the composition and cooling rates. Upon cooling, the precipitation first proceeded discontinuously by the nucleation of nitride needles at subboundaries and subsequent growth of a two-phase microconstituent. At lower temperatures continuous precipitation occurred in the subgrain interior ahead of the discontinuous precipitation interface.

19555 DISORDERED ZONES IN InSb RESULTING FROM IRRADIATION WITH FAST NEUTRONS. Vodop'yanov, L. K.; Kurdiani, N. I. Fiz. Tekh. Poluprov., 1: 646-8(May 1967). (In Russian).

Molten and solidified 1-mm zones possessing electronic conductivity were obtained in crystals of indium antimonide of p-type by irradiation with laser beams. Assuming that such disordered zone is similar to a displacement wedge generated by the fast neutrons, we believe that the conductivity inside the wedge is electronic. Conductivity inversion in InSb crystals of p-type is ascribed to the presence of such displacement wedges. Hole mobility dependence on temperature in neutron irradiated crystals of InSb is ascribed to scattering on disordered zones surrounded by double charged layers. (JPRS)

19556 A MOST STRIKING CONFIRMATION OF THE ENGEL METALLIC CORRELATION. Brewer, L. (Univ. of California, Berkeley). Contract W-7405-eng-48. Acta Met., 15: 553-6 (Mar. 1967). (UCRL-16576).

The Engel correlation between electronic configurations and structures of metals and alloy crystal structures is examined critically. Exceptions and inconsistencies listed by Hume-Rothery are shown to be due to improper application of the theory. For a group of 40 adjoining metals, more than 90% of the predictions of the theory are found to be accurate. A striking confirmation of the theory is the demonstration of intermetallic compounds with enthalpies of formation from –50 kcal/mole up to perhaps –100 kcal/mole. (auth)

19557 DIRECT OBSERVATION OF DISLOCATIONS IN REFRACTORY METALS. Feng, Tuan; Min, Nai-pen. Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh, 9: 165-74(1965). (In Chinese).

A brief description of work carried out on dislocations in Mo and W monocrystals by the pickling method. The etched shapes and their standardization in relation to the dislocations are described. The application of this method to studying the dislocation structure and sub-boundary topography is shown. Results of a study of dislocation structures caused by concentrating tension on the surface, as well as of Mitchell dislocations caused by inclusions in the crystal are presented. (TSS) (Referativnyizh)

19558 INHIBITION OF SINTERING BY DEVELOPING GAS PRESSURE IN THE PORES. Francois, B.; Delmas, R.; Cizeron, G.; Kingery, W. D. (Societe Francaise de Metallurgie, Paris). Mem. Sci. Rev. Met., 64: 1079-94(Dec. 1967). (In French).

In the case of tungsten and uranium dioxide, at the beginning of sintering at 1600°C a sudden arrest of densification is noted; this is associated with the occurrence of a special microstructure. Density and microstructure thus obtained are stable, even after annealing at higher temperatures. Gas is found to be present in the pores. (auth)

19559 NEW COMPOUNDS IN THE SYSTEM DYSPROSIUM–MAGNESIUM AND IN RELATED SYSTEMS. Krypiakewytsch, P. I.; Evdokimenko, V. I. (Iwan-Franko-Univ., Lvov). Z. Anorg. Allg. Chem., 355: 104-12(Nov. 1967). (In German).

The alloys of magnesium with Tb, Dy, Ho, Er, Tu, Yb and Lu (50 to 78 at. % Mg) have been investigated by means of x-ray dif-

fraction analysis. The existence of compounds with the structure types of CsCl (TbMg, DyMg, HoMg, ErMg, TuMg, LuMg), $MgZn_2$ ($DyMg_2$, $TuMg_2$, $LuMg_2$), BiF_3 ($DyMg_3$) and NaTl ($DyMg_x$ with $x \approx 2$) has been established or confirmed. (auth)

19560 RECOVERY OF LATTICE DEFECTS IN ALUMINIUM AND ALUMINIUM-ALLOYS CONTAINING BERYLLIUM, NICKEL, AND TITANIUM AFTER TENSILE DEFORMATION AT 78°K. Lugscheider, Walter; Breitenfellner, Franz; Lihl, Franz (Technische Hochschule, Vienna). Z. Metallk., 59: 22-8(Jan. 1968). (In German).

The recovery process in high purity aluminum (99.99% Al) after tensile deformation at 78°K was analyzed by measurements of the electrical resistivity. The additional resistivity owing to lattice defects produced by plastic deformation was measured during isochronic and isothermal heat treatments. The isochronic investigation exhibits 3 clearly distinguishable recovery stages between 80 and 420°K. Their temperature ranges correspond to stages II, III and IV. The migration energy of the defects could be determined to be 0.20 eV in stage II (80 to 140°K), 0.40 eV in stage III (140 to 250°K) and 0.61 eV in stage IV (250 to 420°K) independent of the order of reaction. Based on the migration energy of single vacancies as determined by quenching experiments the recovery stage III can be ascribed to the annihilation of vacancies. In stage III interstitials and vacancies recombined while in stage II vacancy pairs are most probably annihilating. Changes in grain size between 75 and 750 grains/cm^2 do not influence the defect concentration. Pre-deformation, however, enters additively into the concentration. Small alloying additions (titanium, nickel, beryllium) increase the number of defects but do not change the migration energy of the defects in the various recovery stages. (auth)

19561 REACTIONS OF URANIUM WITH THE PLATINIDE ELEMENTS. I. THE URANIUM–RUTHENIUM SYSTEM. Park, John J. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 72A: 1-10(Jan.-Feb. 1968).

The phase diagram of the uranium–ruthenium system was constructed from data obtained by thermal analysis, metallographic examination, and x-ray diffraction. The system is characterized by five intermetallic compounds: U_2Ru, formed peritectically near 937°C; "URu," melting congruently near 1158°C; U_2Ru_4, formed peritectically near 1163°C; U_3Ru_5, formed peritectically near 1182°C; and URu_3, formed peritectically at about 1850°C. "URu" has a solid-state transition at about 795°C. One eutectic occurs near 886°C and 18.5 atomic percent ruthenium, and a second at about 1148°C and 49 at. % ruthenium. The maximum solid solubilities are about 7.5 at. % ruthenium in uranium and near 1.3 at. % uranium in ruthenium. Ruthenium lowers the gamma-uranium transformation to near 691°C and the beta-transformation to near 625°C. (auth)

19562 REACTIONS OF URANIUM AND THE PLANTINIDE ELEMENTS. II. THE URANIUM–RHODIUM SYSTEM. Park, John J. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 72A: 11-17(Jan.-Feb. 1968).

The phase diagram of the uranium–rhodium system was constructed from data obtained by thermal analysis, metallographic examination, and x-ray diffraction. The system is characterized by four intermetallic compounds: U_4Rh_3, formed peritectically near 1155°C and having a solid-state transformation at about 720°C; U_3Rh_4, formed peritectically near 1450°C; U_3Rh_5, formed peritectically near 1550°C; and URh_3, melting congruently at about 1700°C. One eutectic occurs near 865°C and 24.5 atomic percent rhodium, and a second near 1393°C and 87 at. % rhodium. The maximum solid solubility of rhodium in uranium is approximately 8 at. % and of uranium in rhodium is approximately 3 at. % (auth)

19563 REACTIONS OF URANIUM AND THE PLATINIDE ELEMENTS. III. THE URANIUM–IRIDIUM SYSTEM. Park, John J.; Mullen, Lyle R. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 72A: 19-25 (Jan.-Feb. 1968).

The phase diagram of the uranium–iridium system was constructed from data obtained by thermal analysis, metallographic examination, and x-ray diffraction. The system is characterized by five intermetallic compounds: U_3Ir, formed peritectically near 945°C and decomposing eutectoidally near 758°C; U_3Ir_7, formed peritectically near 1121°C; UIr, melting congruently at about 1470°C; UIr_2, formed peritectically above 1850°C; and UIr_3, having a congruent melting point above 1950°C. U_3Ir_2 has a solid state transition near 898°C. One eutectic occurs at 914°C at about 15 atom percent iridium between uranium and U_3Ir; a second occurs between UIr and UIr_2 near 1450°C; and a third occurs between UIr_3 and iridium at about 1950°C. The solid solubility of iridium in gamma-uranium is about 5.5 at. % and of uranium in iridium is under 3 at. %. Iridium lowers the gamma-beta uranium transformation to about 681°C and the beta-alpha transformation to about 565°C. (auth)

19564 STRESS-INDUCED GROWTH OF GAS BUBBLES IN SOLIDS. Stiegler, J. O.; Farrell, K.; McCoy, H. E. (Oak Ridge, National Lab., Tenn.). Contract W-7405-eng-26. J. Nucl. Mater., 25: 340-3(1968). (ORNL-P-3523).

Experimental observations are described which support the critical stress model of bubble growth in solids. Creep-rupture specimens of chemical vapor deposited tungsten were used to show that bubble growth in solids can and does occur under stress at elevated temperatures to form cracks and that there is a critical stress below which runaway growth of bubbles of a given initial size does not occur. (F.S.)

19565 THE CRYSTAL STRUCTURE OF U_2Co_2Al. Sampaio, A. O. (Laboratoire de Fisica e Engenharia Nucleares, Sacavem, Portugal); Santa Marta, E.; Lukas, H. L.; Petzow, G. J. Less-Common Metals, 14: 472-3(Apr. 1968).

During an investigation of the U–Al–Co system in the section $U–UCo_2–UAl_2$ a new phase with the composition U_2Co_2Al was found. The x-ray patterns could be indexed as due to a tetragonal unit with the lattice constants a = 7.091 and c = 3.461 Å (c/a = 0.488). The density was 11.3 g cm^{-3}. (M.C.G.)

19566 THE CONSTITUTION OF SOME R.E.Pt_3 ALLOYS. Harris, I. R. (Univ. of Birmingham, Eng.). J. Less-Common Metals, 14: 459-62(Apr. 1968).

Alloys corresponding to the compositions $LaPt_3$, $CePt_3$, $PrPt_3$, $NdPt_3$, $SmPt_3$, $RuPt_3$, $GdPt_3$, $TbPt_3$, $DyPt_3$, and a range of Pt–Ce alloys were prepared by arc melting. X-ray examination showed that the alloys consist predominantly of the C15 ($MgCu_2$-type) phase, both in the as-cast condition and after homogenizing for one week at 900°C. (M.C.G.)

19567 DIFFUSION IN STABILIZED DELTA PLUTONIUM. I. GALLIUM. Edwards, G. R.; Tate, R. E.; Hakkila, E. A. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Nucl. Mater., 25: 304-9(1968). (LA-DC-9038).

Interdiffusion coefficients were measured on fcc low-gallium (3.0 and 7.9 at. %) plutonium alloy couples annealed at 350 to 517°C. Concentration-penetration data obtained with an electron microprobe analyzer were fitted by a least-squares technique to give the following Arrhenius relationship $\tilde{D} = 1.3 \exp[-37{,}350$ cal/RT] cm^2/sec. (auth)

19568 STACKING FAULT PROBABILITY DETERMINATION FROM PEAK SHIFTS IN PLASTICALLY DEFORMED THORIUM. Krishnan, R. (Bhabha Atomic Research Centre, Bombay). Z. Metallk., 59: 130-3(Feb. 1968).

The effects of cold-work on x-ray diffraction line positions of rolled slab of thorium and of thorium filings were investigated. The importance of peak-shifts arising from residual stresses in the bulk sample is emphasized here. It is shown that the positions of higher order peaks only determine whether the peak-shifts are due to stacking faults or residual stresses. After eliminating the peak-shift due to residual stresses, the stacking-fault probability of thorium has been computed to be about 0.005. As this fault density is not significantly different from experimental error, it is concluded that thorium belongs to the group of high stacking-fault energy metals. (auth)

19569 THE SYSTEM URANIUM–UAl_2–UCo_2. Sampaio, A. Oliveira; Santa Marta, E.; Petzow, Guenter (Laboratorio de Fisica e Engenheria Nucleares, Sacavem, Portugal. Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 59: 118-24(Feb. 1968). (In German).

Phase relations in the uranium-rich part of the system U-Co-Al, limited by the pseudobinary section UCo_2-UAl_2, have been determined by thermal, chemical, microscopic and x-ray investigations. An U_3Si_2-type ternary phase with composition U_2Co_2Al, being formed by a peritectic reaction, was found as well as a pseudobinary section between the uranium corner and the intermetallic compound $U(Co,Al)_2$ in the system UCo_2-UAl_2. The constitutional diagram is represented by liquidus planes, four-phase reactions, isothermal sections for 900, 800, 700, and 600°C, as well as temperature-concentration diagrams. The system is dominated by extended heterogeneous ranges which only exhibit small ternary extensions, including the new phase U_2Co_2Al. (tr-auth)

19570 PROPERTIES OF HIGH ZIRCONIUM Cu–Zr–Cr ALLOYS AND THEIR ISOTHERMAL DIAGRAM OF THE COPPER CORNER. Kawakatsu, Ichiro; Suzuki, Hisashi; Kitano, Hitoshi

(Tokyo Univ.). Nippon Kinzoku Gakkaishi, 31: 1253-7(1967). (In Japanese).

Properties of Cu-Zr-Cr alloys containing more than about 0.5% zirconium and various amounts of chromium have been studied. The isothermal sections of copper corner of Cu-Zr-Cr equilibrium diagram mainly at 950 and 900°C have also been studied. It was found that the properties of the alloys were little affected by the composition changes. The optimum composition of the alloys showing high strength and electric conductivity was in the range of about 0.5 ~ 0.8% Zr and 0.5 ~ 1.2% Cr. The isothermal sections consisted of four different phase fields, i.e., α, α + Cr, α + Cr + Cu_3Zr and α + Cu_3Zr. The α phase field was extended toward the opposite direction to the copper corner. The same inter-phase relationship could also be found at lower temperatures. The properties of the alloys were considered to be well explained using the above diagram. (auth)

Radiation Effects

Refer also to abstracts 19669, 19670, and 20049.

19571 (AERE-M-1977) SWELLING MEASUREMENTS OF IRRADIATED FUEL SPHERES BY MICRORADIOGRAPHY. Keep, R. H. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1967. 13p. Dep. CFSTI. UK 4s. 0d.

A microradiographic technique was developed for measuring the change in volume of small fuel samples due to irradiation to high burn-ups. The fuel samples are in the form of accurately ground 500μ spheres, which may have a restraining coat of pyrocarbon or pyrocarbon and silicon carbide. Specimens given radiation doses up to 600 mr/hr/$\beta\gamma$ at 1 ft were successfully radiographed. Dimensions were obtained to an accuracy of better than 1½% using a semi-automatic scanning device. Information was also obtained on irradiation induced defects in the coatings. (auth)

19572 (BNWL-455) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, February-April 1967. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 15, 1967. Contract AT(45-1)-1830. 272p. Dep. CFSTI.

Ten reports on irradiation effects on reactor structural materials are presented. A separate abstract was prepared for each. (L.C.L.)

For abstracts of individual sections see: 19511, 19512, and 19573-19580.

19573 (BNWL-455, Paper 3.1-8) IRRADIATION EFFECTS ON V-20 Ti AND V-15 Ti-7.5 Cr ALLOYS. Carlander, R.; Murphy, W. F. (Argonne National Lab., Ill.).

Tensile tests on vanadium alloys which are candidate materials for LMFBR fuel jackets were performed to study the effects of fast neutrons at reactor temperatures. Tensile-type and tube specimens were tested from room temperature to 750°C. Neutron exposures ranged from 5×10^{21} to 1×10^{23} n/cm^2 and irradiation temperatures from 500 to 700°C. The results showed that, for the tensile type specimens, irradiation effects apparently were annealed out at high irradiation temperatures. The tube burst tests showed a maximum increase in burst strength of 27% at 550°C, 13% at 650°C, and at 750°C no increase exists due to irradiation. At both 650 and 750°C the unirradiated specimens showed about twice the ductility of the irradiated. (L.C.L.)

19574 (BNWL-455, Paper 4.1-18) RADIATION-INDUCED PROPERTY CHANGES IN STRUCTURAL MATERIALS. Wullaert, R. A. (Battelle Memorial Inst., Columbus, Ohio).

The radiation-induced mechanical property changes in AISI type 347 SS after irradiation were studied primarily to determine the irradiation-induced embrittlement at elevated temperatures which occurs in stainless steels and nickel alloys. Evaluations of the radiation effects were made on the basis of tensile tests and metallographic examinations. The influence of long-time heat treatments on the mechanical properties of type 347 SS and type 348 SS was investigated. The test results are tabulated. (L.C.L.)

19575 (BNWL-455, Paper 5.1-10) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIAL PROGRAM. (Brookhaven National Lab., Upton, N. Y.).

The effects of neutron irradiation on the surface structure and mechanical properties of reactor structural materials, such as cobalt alloys, iron alloys, platinum, and tungsten, were investigated. (L.C.L.)

19576 (BNWL-455, Paper 6.1-9) A RESEARCH PROGRAM ON THE EFFECT OF SUBSTRUCTURE ON THE IRRADIATION STABILITY OF ASTM A302 GRADE B STEEL. Trozera, T. A.; Flynn, P. W. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

The effect of substructure on the irradiation stability of a typical reactor pressure vessel steel, ASTM A302-B, was studied. First, the effect of substructure on the mechanical properties of nonirradiated A302-B steel was evaluated, and improvements in these mechanical properties achieved by cold working and heat treatments were noted. Then, the effects of neutron irradiation on the properties of this steel with and without well-defined substructure were determined. (L.C.L.)

19577 (BNWL-455, Paper 9.1-34) RESEARCH PROGRESS. Hawthorne, J. R.; Serpan, C. Z. Jr.; Watson, H. E.; Gray, R. A. Jr. (Naval Research Lab., Washington, D. C.).

Research results are reported on effects of neutron irradiation on structural steels, effects of O and N on radiation embrittlement sensitivity of steels, ductility of irradiated maraging steel weldments, annealing effects on irradiated steel, tensile properties of pressure vessel steel, in-pile irradiation testing of steel, and design and operation of remote milling machines and metallurgical equipment. (J.R.D.)

19578 (BNWL-455, Paper 10.1-40) EFFECT OF RADIATION ON REFRACTORY METALS AND HEAT RESISTANT ALLOYS. Moteff, J. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Results of research are reported on neutron effects on W, W-25Re alloys, Mo, and TZM. (J.R.D.)

19579 (BNWL-455, Paper 11.1-18) RADIATION EFFECTS IN FUEL CLADDING MATERIALS. (Oak Ridge National Lab., Tenn.).

Results of research are reported on effects of in-pile irradiation of type 304 stainless steel, effects of cyclotron-injected He on type 304 stainless steel, effects of 0.2 wt % Ti addition on type 304 stainless steel, electron microscopy of irradiated stainless steels, in-pile irradiation of Hastelloy N and measurement of nuclear heating in EBR-II. (J.R.D.)

19580 (BNWL-455, Paper 12.1-100) IRRADIATION DAMAGE TO REACTOR METALS. Bement, A. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Results of research are reported on reactor metals, irradiation damage to stainless steels, irradiation damage to Ni-base alloys, radiation effects on solid-solution hardened alloys, radiation effects on SAP, in-pile measurements of mechanical properties, electric conductivity, effects of high pressure on radiation damage to solids, high-pressure equipment, in-pile irradiation, and corrosion of metals and alloys. (J.R.D.)

19581 (BNWL-SA-1598) IN-REACTOR CREEP OF ZIRCONIUM ALLOYS. Gilbert, E. R.; Bement, A. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 18, 1968. Contract AT(45-1)-1830. 14p. (CONF-680105-3). Dep. CFSTI.

From Industry Meeting on Water Reactor Fuel Element Technology, Germantown, Md.

In-reactor creep tests on two zirconium alloys, Zircaloy-2 and Zr-2.5 Nb, were conducted to determine the effect of concurrent irradiation on creep at different stresses and temperatures. The design of the creep test capsule is described, and the tests results are presented. The Zr-2.5 Nb offers an advantage in lower creep rates at high stress levels greater than 21 kg/mm^2 (30,000 psi). At lower stress levels both alloys have approximately the same in-reactor creep rates. (L.C.L.)

19582 (BNWL-SA-1611) IN-REACTOR CORROSION OF ZIRCONIUM ALLOYS. Johnson, A. B. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 29, 1968. Contract AT(45-1)-1830. 11p. (CONF-680105-4). Dep. CFSTI.

From Industry Meeting on Water Reactor Fuel Element Technology, Germantown, Md.

A series of in-reactor experiments was run to determine the influence of variables such as coolant composition, alloy composition, and pretreatment procedures, on the flux-induced corrosion of zirconium alloys. Six zirconium alloys were tested in the ETR G-7 loop operated with pH-10 LiOH and with pH-10 NH_4OH. Specimens were either as-etched or prefilmed. The results showed that all three variables are significant, and that the response of the different alloys to in-flux corrosion is complicated. Niobium appeared to increase resistance to in-flux corrosion in the alloys tested. (L.C.L.)

19583 (COO-1198-511) STAGE III ANNEALING IN GOLD AFTER ELECTRON IRRADIATION. Lee, Choochon (Illinois Univ., Urbana). Feb. 1968. Contract AT(11-1)-1198. 189p. Dep. CFSTI.

Gold specimens of nominal 99.9999% purity were irradiated with 3 MeV electrons near liquid nitrogen temperature. The damage production rate is found to depend on the purity of the specimen giving a lower value for the high purity specimens. It is also

found that the production rate is reduced remarkably by quenching the specimen before irradiation. For high purity gold, a single large annealing peak is observed in Stage III. The slope change method and Primak analysis are employed to obtain the activation energy of Stage III annealing. Both methods give 0.85 ± 0.02 eV for the activation energy in high purity irradiated specimens. The activation energies for quenched, and quench-plus-irradiated specimens of comparable purity are found to be 0.85 ± 0.03 eV and 0.86 ± 0.02 eV respectively, agreeing with the value for the irradiated specimens within the experimental error. Somewhat lower values are obtained for specimens of lower purity. Second order kinetics are obeyed in the main part of the Stage III annealing for the irradiated, quench-plus-irradiated and quenched specimens. Various models are discussed to explain Stage III annealing. It is concluded that vacancy migration in Stage III with interstitial clusters acting as sinks can account for the observed results most satisfactorily in the case of gold. (auth)

19584 (GA–8064) A RESEARCH PROGRAM ON THE EFFECT OF SUBSTRUCTURE ON THE IRRADIATION STABILITY OF ASTM A302 GRADE B STEEL. Final Report. Trozera, T. A.; Flynn, P. W. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Aug. 1, 1967. Contract AT(04-3)-167. 95p. (EURAEC–1928). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The steel was quenched and tempered A302-B steel. The tensile properties in the three principal directions of the plate were within ±2%. Several combinations of cold work and heat treatment were used to produce yield strength increases of 35% over the quenched and tempered condition while maintaining the same uniform strain. The treatment producing the best mechanical properties caused a 32°C increase in the Nil Ductility Transition. The irradiations were performed in the Low Intensity Test Reactor at <100°C and 288°C. Capsules received fast fluences in the range 1.5×10^{18} to 5.2×10^{19} nvt. Nonirradiated and irradiated samples of quenched and tempered material and of material that had been cold worked and heat treated were then tested at 22, 157, and 288°C. For the tensile and tube specimens, the load and elongation or diametral expansion were autographically recorded. Standard Charpy impact tests were performed to plot the transition temperature, and the Charpy impact machine was also instrumented to provide details on energy distribution during fracture. The yield and tensile strength of A302-B steel can be increased by suitable cold work and heat treatment without a loss in uniform elongation. This improvement persists after irradiation but does not reduce loss of uniform strain at large fluences. The predicted instability strain in the tube (biaxial) test is not exceeded and is valid as an upper limit. An appropriate cold work and heat treatment may decrease radiation sensitivity in the Charpy impact test and may also increase energy absorption in propagating a brittle fracture. Interstitials collecting on subgrain boundaries may be the key element in the observed substructure strengthening. A constant cell size appears to be reached at small amounts of cold work followed by heat treatment. (auth)

19585 (NRL–6620) THE EFFECTS OF COUPLING NUCLEAR RADIATION WITH STATIC AND CYCLIC SERVICE STRESSES AND OF PERIODIC PROOF TESTING ON PRESSURE VESSEL MATERIAL BEHAVIOR. Hawthorne, J. R.; Loss, F. J. (Naval Research Lab., Washington, D. C.). July 25, 1967. Contract AT(49-5)-2110. 39p. Dep. CFSTI.

The nuclear service performance of structural steels as influenced by static and cyclic stress applications during radiation exposure has been examined and documented with experimental results. The significance and merits of initial and subsequent proof tests of large structural components such as the hydrotesting of nuclear reactor pressure vessels have also been reviewed and evaluated. Performance following preload in the form of warm prestressing as well as aging embrittlement were among those factors considered. A summary review of available data representing a coupling of static stress and radiation has suggested neither a significant effect of stress on irradiation responses, nor a synergistic effect of stress and radiation on mechanical properties performance. New data also indicate that stress during irradiation may not have a general influence on post-irradiation annealing response. A parallel review of the cyclic stress behavior of pressure vessel steels did reveal a slight alteration of basic (preirradiation) low-cycle fatigue properties by neutron exposure. The general trend depicted was one of a radiation reduction of fatigue life at high strain amplitudes (low-cycle failure region) and of improvement at low strain amplitudes (high-cycle region). The trend was found consistent for both pre-post irradiation test methods and dynamic in-reactor testing. Evaluations of the merits and objections for proof testing allowed a conclusion that both initial and periodic proof tests conducted above the nil-ductility transition temperature (NDT) are of definite value; however, operations below NDT either as a proof test or subsequent to warm prestressing above NDT were found objectionable. (auth)

19586 (RD/B/N–1008) THE RELEASE OF ^{85}Kr FROM IRRADIATION URANIUM DURING OXIDATION IN CO_2 BETWEEN 500° AND 700°C. Hilton, D. A. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb. 1968. 16p. Dep.

The active gas was monitored at 10 sec intervals by a β-scintillation flow counter coupled to a multichannel analyser which was used as a multiple scaler. In the initial parabolic stage of oxidation the rate of ^{85}Kr release was also parabolic at 500 to 625°C, and both processes showed the same activation energy. Over long periods of oxidation ^{85}Kr is released as a result of oxide cracking. The activity released is generally proportional to the weight gain, and this is probably due to the rate of crack propagation being equal to the rate of oxide growth at the metal-oxide interface. Up to 75% of the ^{85}Kr originally present in the metal can be retained by the non-adherent oxide; this activity is completely released by air oxidation above ~350°C. Partial oxidation in the β-phase results in the additional release of ^{85}Kr during cooling, due to disruption of the oxide as a consequence of the β-α phase change. (auth)

19587 EFFECTS OF IRRADIATION ON BERYLLIA-BASED FUELS. Hickman, B. S.; Rotsey, W. B.; Hilditch, R. J.; Veevers, K. (Australian Atomic Energy Commission Research Establishment, Sydney). J. Amer. Ceram. Soc., 51: 63-9(Feb. 21, 1968).

Dispersions of $(UTh)O_2$ in beryllia containing 1.7 to 25 vol % $(UTh)O_2$ in coarse (150 to 200μ), medium (33 to 35μ), and fine (<10 and <5μ) fuel particle sizes were irradiated to burnups of 3 to 10% of heavy metal atoms at 300 to 900°C, in both fast and thermal fluxes. Changes in volume, lattice parameter, line breadth, and modulus of rupture were measured; volume changes in the fine dispersions were ascribed wholly to fission fragment damage and were about 50% greater than those caused by fast neutrons alone; they increased with increasing fission fragment flux, and decreased as irradiation temperature increased. Volume changes in medium and coarse dispersions were about 25% greater than those caused by fast neutrons alone; the increased damage is attributed to the additional β-flux. As fuel particle size increased, deterioration in strength under irradiation was more marked. This was attributed to more intense fission fragment damage in the recoil zone around larger particles causing volume increases which exceeded those of the remainder of the matrix. For maximum initial strength and retention of strength under irradiation, the fuel particle size should not exceed 5μ, and the interparticle spacing should not exceed 30μ. (auth)

19588 RADIATION EMBRITTLEMENT OF PRESSURE VESSELS AND PROCEDURES FOR LIMITING THIS EFFECT IN POWER REACTORS. Steele, L. E.; Knighton, G. W.; Potapovs, U. (Div. of Reactor Development and Technology, Washington, D. C.). Nucl. Appl., 4: 230–44(Apr. 1968).

Results of investigations have shown that neutron radiation increases the strength and reduces the ductility of reactor vessel steels. The extent of steel embrittlement is a function of the steel, the irradiation environment (neutron energy and fluence), and the irradiation temperature. In some cases, as with the compact Army SM-1A reactor, the embrittlement may become severe enough to require modification of reactor operating procedures to avoid a significant stress on the vessel when its temperature approaches the nil ductility transition temperature (NDT). The SM-1A vessel was heat treated by raising the vessel temperature from the usual 430°F to 572°F and holding it there for about one week using reactor heat from low power operation. In addition to operational procedures for minimizing the effects of neutron exposure to reactor vessel steels, design approaches used to meet this problem include specifying (based on experiment) a radiation insensitive steel, shielding the vessel to reduce neutron exposure to a level consistent with the design lifetime of the plant, and providing for periodic in-place annealing using reactor heat. (J.R.D.)

19589 TUBE BURST TESTS ON IRRADIATED EBR-II TYPE 304L STAINLESS STEEL FUEL CLADDING. Murphy, W. F.; Strohm, H. E. (Argonne National Lab., Ill.). Nucl. Appl., 4: 222-9(Apr. 1968).

Segments of Type 304L stainless steel cladding from irradiated EBR-II fuel elements have been used for burst tests from room temperature to 1000°C. The cladding had accumulated exposures of 0.5 to 1.4×10^{22} n/cm² (>0.1 MeV) at 370 to 500°C. In burst tests at ≤700°C, the greater strength was on the lower half of the irradiated cladding where the irradiation temperature was <475°C. Tests at 800, 900, and 1000°C each showed uniform strength along the lengths of the cladding. The strength of the irradiated specimens decreased most rapidly with temperature at 400 to 700°C.

Unirradiated specimens were weaker than irradiated ones below 700°C; above 700°C the unirradiated specimens were slightly stronger. The irradiated and the unirradiated specimens had low uniform strain (~1% and ~10%, respectively) at test temperatures of ~400 to 500°C. (auth)

19590 RADIATION DAMAGE IN IRON AND STEEL. Hall, E. O. (Univ. of Newcastle, New South Wales). At. Energy Aust., 11: 2-5(Jan. 1968).

A discussion of radiation damage processes is presented and the effects of the neutrons on the mechanical properties of mild steel are discussed. Stress strain curves for irradiated and nonirradiated stainless steel are compared. The low energy absorption to fracture as a function of temperature for embrittled steel is given. (F.S.)

19591 INFLUENCE OF NEUTRON IRRADIATION ON THE PLASTIC DEFORMATION OF IRON-SINGLE CRYSTALS WITH DIFFERENT CARBON CONTENT. III. WORK-HARDENING PARAMETERS. Seidel, Gerd-Peter (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 59: 88-93(Jan. 1968). (In German).

The dependence of the stress-strain curves of neutron irradiated iron single crystals on the carbon content, the neutron dose and the deformation temperature, are studied in detail with the help of the work-hardening parameters. The slopes and extensions of the linear work-hardening stages depend strongly on the neutron dose and impurity content (carbon). In addition, the slope depends strongly on the crystal-orientation. Qualitatively these results correspond to the behavior of face-centered cubic metals. In contrast to these it was found, however, that the slope increases with deformation temperature. (auth)

19592 INFLUENCE OF NEUTRON IRRADIATION ON THE PLASTIC DEFORMATION OF IRON-SINGLE-CRYSTALS WITH DIFFERENT CARBON CONTENTS. II. STRESS-STRAIN CURVES. Seidel, Gerd-Peter (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 59: 82-8(Jan. 1968). (In German).

The influence of neutron irradiation on the stress-strain curves of iron single crystals of two different carbon contents (20 and ≤8 ppM by weight) was investigated. The measurements were carried out in dependence of the neutron dose, the deformation temperature and after different annealing treatments. In comparison the stress-strain curves of unirradiated samples were measured. The stress-strain curves of crystals with orientations in the interior of the unit triangle show at higher temperatures (≥ 273°K) three-stage-hardening similar to those of face-centered cubic metals; at lower temperatures they are monotonically curved. The shape of the stress-strain curve of unirradiated crystals depends on the carbon content. The influence of neutron irradiation on the stress-strain curves is more pronounced for crystals with higher carbon content, than for those with less carbon content. (auth)

19593 THE EFFECT OF FISSION NEUTRON IRRADIATION UPON THE OXIDATION OF A 20 wt PERCENT Cr/25 wt PERCENT Ni/Nb STABILIZED STAINLESS STEEL BY CARBON DIOXIDE BETWEEN 580 AND 840°C. Bennett, M. J.; Blythe, P. C.; Chaffey, G. H.; Hand, K.; McMillan, J. W.; Webster, S. J.; Antill, J. E. (United Kingdom Atomic Energy Authority, Harwell, Eng.). J. Nucl. Mater., 25: 260-70(1968).

The effect of simultaneous irradiation with fission and Westcott neutron fluxes of 3×10^{13} and 8×10^{12} n/cm^2 · sec on the oxidation of a 20/25/Nb stainless steel by carbon dioxide has been studied at 580 to 840°C. The duration of irradiation was 10,293 hr, although the time at temperature and hence that for oxidation was in most cases less than this, the minimum being 5002 hr. Direct comparison of the in-reactor results with out-of-reactor control data indicated that at all temperatures the irradiation had not affected the magnitude of attack or the percentage of non-adherent oxide to within a factor of 2, the limit of reproducibility. The distributions between the metal and oxide of the isotopes ^{60}Co, ^{182}Ta and ^{54}Mn, produced by the irradiation, were also determined and were compared with data for unirradiated specimens. (auth)

19594 INTERPRETATION OF THE EFFECT OF A FOREIGN ELEMENT ON THE PHENOMENA OF RESTORATION OBSERVED ABOVE 78°K IN ALUMINUM IRRADIATED WITH NEUTRONS OR ELECTRONS. Dimitrov-Frois, Colette; Dimitrov, Omourtague (Centre d'Etudes de Chimie Metallurgique, Vitry-sur-Seine, France). Compt. Rend., Ser. C, 266: 304-6(Jan. 29, 1968). (In French).

A theoretical model was previously proposed that permitted the interpretation of the restoration curves determined for several dilute aluminum alloys irradiated by fast neutrons at 78°K (Al–Mg, Al–Cu, Al–Ag). Now it is proposed to show that this model permits the explanation of the results obtained after irradiation with neutrons or electrons of alloys containing other elements in addition. This discussion will be limited to the restoration phenomena studied above 78°K by measuring the electric resistivity. (tr-auth)

19595 EFFECTS OF RADIATION ON STRUCTURAL METALS. A Symposium Presented at the Sixty-ninth Annual Meeting, American Society for Testing and Materials, Atlantic City, N. J., June 26–July 1, 1966. ASTM Special Technical Publication No. 426. Philadelphia, American Society for Testing and Materials, 1967. 719p. $52.00. (CONF-660607).

Some Papers from this Symposium were Cataloged under CONF-660627.

A total of 29 papers were presented at the symposium. A separate abstract was prepared for each of nine papers. Papers for which no abstracts were prepared are concerned with mechanical properties, heat treatment, cladding, and metallurgical variables. (J.R.D.)

For abstracts of individual papers see: 19596–19604.

19596 IRRADIATION DAMAGE IN MILD STEEL: A COMPARISON OF CRACK ARREST TEST AND CHARPY CRITERIA AND INFLUENCE OF NEUTRON SPECTRUM. Cowan, A.; Fearnehough, G. D.; Gillies, J.; Lees, G. M. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). pp 107-34 of Effects of Radiation on Structural Metals. Philadelphia, American Society for Testing and Materials, 1967. (TRG-Report-1069; JNPC-MWP-SSG/P(66)19).

From 3rd International Symposium on the Effects of Radiation on Structural Metals, Atlantic City. See CONF-660607.

Irradiation of crack arrest test specimens and Charpy V-notch specimens under identical conditions showed good correspondence in evaluation of irradiation embrittlement effects. Thus, changes in Charpy V-notch monitoring or surveillance specimens can be used when reactor pressure vessel operating limits are based on crack arrest criteria. Charpy specimens of the same steel irradiated in three different reactors show that, when damage is expressed in terms derived from activation of nickel monitors, measured changes for a given dose can vary by a factor of two. However, when the damage index is taken as the total number of atoms displaced in each reactor facility, the agreement with measured damage improves to better than ±15%. Thus, with a knowledge of neutron spectra, it is possible for a given steel specimen to give a reliable prediction of damage from one reactor to another. (auth)

19597 REVIEW OF SWEDISH WORK ON IRRADIATION EFFECTS IN CANNING AND CORE SUPPORT MATERIALS. Grounes, M. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 200-23 of Effects of Radiation on Structural Metals. Philadelphia, American Society for Testing and Materials, 1967.

From 3rd International Symposium on the Effects of Radiation on Structural Metals, Atlantic City. See CONF-660607.

A survey is given of irradiation-effects studies made and in progress on several different materials under varying conditions. Tension specimens of Zircaloy-2 with varying hydrogen contents were irradiated to neutron doses above 7×10^{21} n/cm^2 (>1 MeV) at 40°C and to 5×10^{19} n/cm^2 (>1 MeV) at 220 to 270°C. Stress-relaxation tests of Zircaloy-2 and Zr-2.5% Nb are in progress at 270°C to 10^{19} n/cm^2 (>1 MeV). Tension specimens of annealed and cold-worked steels similar to AISI Types 304 and 316 were irradiated to 4×10^{21} n/cm^2 (>1 MeV) at 40°C and about 5×10^{20} n/cm^2 (>1 MeV) at 270°C. Tension specimens of nickel-base alloys (Hastelloy X, Incoloy 800, 20Cr/25Ni/Nb) were irradiated at 550 to 700°C to 10^{20} to 10^{21} n/cm^2 (>1 MeV). Impact tests were made on AISI 406 steel (13% Cr, 4% Al) after 10^{20} n/cm^2 (>1 MeV) at 550°C. Work in progress on postirradiation creep, in-pile creep, in-pile fatigue, and in-pile corrosion is briefly described. The significance of irradiation-effects data is discussed for in-pile loop tubes in a materials testing reactor. (auth)

19598 REVIEW OF SWEDISH WORK ON IRRADIATION EFFECTS IN PRESSURE VESSEL STEELS AND ON SIGNIFICANCE OF DATA OBTAINED. Grounes, M. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 224-59 of Effects of Radiation on Structural Metals. Philadelphia, American Society for Testing and Materials, 1967.

From 3rd International Symposium on the Effects of Radiation on Structural Metals, Atlantic City. See CONF-660607.

Tension and impact specimens of several Swedish and U.S. pressure vessel steels have been irradiated to doses between 2×10^{18} and 3×10^{19} neutrons (n)/cm^2 (>1 MeV) at 40 to 550°C. A saturation effect with respect to dose is obtained in some, but not all, steels at higher irradiation temperatures. Similar steels and even different heats of the same steel in some cases behave differently after irradiation. An attempt has been made

to correlate the difference observed when irradiations were made in two different neutron spectra with calculated differences between the two spectra. A method for estimating the brittle-fracture tendency of pressure vessels is described. The crack-propagation transition temperature is used as a criterion of safety. An estimate of this transition temperature at the end of the reactor's lifetime must take effects due to fabrication, welding, geometry, aging, and irradiation into account. The magnitudes of the different factors influencing the final transition temperature are discussed, and the data for the Marviken reactor's pressure vessel are presented. (auth)

19599 AN EVALUATION OF RADIATION DAMAGE TO REACTOR VESSEL STEELS USING BOTH TRANSITION TEMPERATURE AND FRACTURE MECHANICS APPROACHES. Landerman, E.; Yanichko, S. E.; Hazelton, W. S. (Westinghouse Electric Corp., Pittsburgh, Pa.). pp 260-77 of Effects of Radiation on Structural Metals. Philadelphia, American Society for Testing and Materials, 1967.

From 3rd International Symposium on the Effects of Radiation on Structural Metals, Atlantic City. See CONF-660607.

As part of the Westinghouse APD irradiation effects program on structural materials, fracture toughness specimens including both Charpy V impact tests (transition temperature approach) and wedge opening loading (WOL) specimens (fracture mechanics approach) were irradiated. The reactor vessel materials investigated were two heats of SA302 Grade B including the ASTM reference correlation monitor material. The shift in the nil-ductility transition temperature (NDTT) based on Charpy impact tests and the change in fracture toughness based on WOL tests were determined. The neutron doses were 2.7×10^{19} to 1.25×10^{20} n/cm^2 > 1 MeV at 550°F. Because of transition temperature shifts, stresses would be limited in the temperature range of 220 to 405°F during normal startup and shutdown procedures for reactor vessels. However, fracture mechanics tests showed that flaws greater than 9 in. in depth under stresses of 10,000 psi would not limit operating procedures at temperatures above 300°F. (auth)

19600 PROPERTIES OF IRRADIATED MATERIALS NEEDED FOR THE DESIGN OF REACTOR VESSELS. PART I. WATER COOLED REACTORS. McLaughlin, D. W. (Mechanical Technology Inc., Latham, N. Y.). pp 391-407 of Effects of Radiation on Structural Metals. Philadelphia, American Society for Testing and Materials, 1967.

From 3rd International Symposium on the Effects of Radiation on Structural Metals, Atlantic City. See CONF-660607.

Properties of metals and application of data on radiation effects are discussed from the designers viewpoint. It is concluded that radiation effects on brittle fracture transition temperatures and fatigue resistance are the primary problems. A summary of materials data, needed for design of water cooled reactors, is given in a table as are data on reactor vessels now in service. (P.G.C.)

19601 NATURE OF RADIATION DAMAGE TO ENGINEERING PROPERTIES OF VARIOUS STAINLESS STEEL ALLOYS. Irvin, J. E.; Bement, A. L. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. pp 278-327 of Effects of Radiation on Structural Metals. Philadelphia, American Society for Testing and Materials, 1967.

From 3rd International Symposium on the Effects of Radiation on Structural Metals, Atlantic City. See CONF-660607.

Austenitic (AISI Types 304, 348, AM-350), ferritic (AISI Type 406), and martensitic (AISI Type 410) stainless steels have been irradiated in aqueous and gaseous environments at several irradiation temperatures to 750°C. Tensile tests were performed at several test temperatures between 20 and 750°C on specimens with integrated neutron exposures to 6.0×10^{21} nvt (>1 MeV). The combined effects of irradiation and test temperature produce minimum ductility at 200 to 400°C and at 600 to 800°C. The significance of these minima with respect to the preirradiation thermal/mechanical treatment, irradiation temperature, neutron fluence, and deformation temperature are discussed. The effects of aging, annealing, recovery, and grain growth are examined. Control tests were performed to determine the effects due to environment alone. Selected parameters such as heat-treatment, cold work, composition, and orientation are considered. Postirradiation annealing studies were performed to determine what portion of the tensile ductility was recoverable after irradiation in significantly different spectra. (auth)

19602 EFFECT OF NEUTRON IRRADIATION ON MECHANICAL PROPERTIES OF AISI TYPE 347 STAINLESS STEEL. Kangilaski, M.; Shober, F. R. (Batelle Memorial Inst., Columbus, Ohio). Contract W-7405-eng-92. pp 487-511 of Effects of Radiation on Structural Metals. Philadelphia, American Society for Testing and Materials, 1967.

From 3rd International Symposium on the Effects of Radiation on Structural Metals, Atlantic City. See CONF-660607.

Changes in mechanical properties induced by irradiation of AISI Type 347 stainless steel at about 60°C were determined after integrated fast-flux (>1 MeV) exposures of 1.6×10^{22} and 2.1×10^{22} n/cm^2. Tension tests were performed at room temperature, 316, and 750°C. The results indicated that the ultimate tensile strength and yield strength were greater after irradiation, with the yield strength showing the greater increase. After an exposure of 2.1×10^{22} n/cm^2, the ratio of yield strength to ultimate strength was approximately 1. The decreases in ductility as measured by total and uniform elongation at 20°C were about the same magnitude for both levels of irradiation. The ductility at 316°C continued to decrease as a function of increasing neutron exposure. Radiation-induced property changes differed only slightly from those observed after irradiation to 5.5×10^{21} n/cm^2 with the exception of the uniform and the total elongation at 316°C, suggesting that saturation of displacement damage occurred prior to this exposure. The fracture mode for both unirradiated and irradiated specimens was transgranular. Annealing of irradiated specimens for 1 hr at 982°C restored the preirradiation mechanical properties at 316°C. A severe reduction in ductility was noted for specimens tested at 750°C after irradiation to 2.1×10^{22} n/cm^2, showing only about 0.5% as uniform and total elongation. The fracture mode was intergranular. Annealing for 1 hr at 982 and 1350°C did not change the as-irradiated ductility. Room-temperature cyclic-strain fatigue tests were made on Type 347 stainless steel specimens after irradiation to 5.5×10^{21}, 1.1×10^{22}, and 1.6×10^{22} n/cm^2. The results indicated that the fatigue life at room temperature for stainless steel decreased at high strains, >1.5% total strain per cycle, and increased at low strains, <0.5% total strain per cycle, as a result of irradiation. The stress to produce the same total strain per cycle was greater after irradiation and increased with increasing irradiation levels. The failure time was a function of the total plastic strain and appeared to follow the relationship $N^m \Delta\epsilon_t = C$, where N is the number of cycles to failure. $\Delta\epsilon_t$ is the total strain range, and m and C are constants. (auth)

19603 EFFECTS OF NEUTRON IRRADIATION ON CREEP-RUPTURE PROPERTIES OF W-^{25}Re ALLOY. Kingsbury, F. D.; Moteff, J. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. pp 512-33 of Effects of Radiation on Structural Metals. Philadelphia, American Society for Testing and Materials, 1967.

From 3rd International Symposium on the Effects of Radiation on Structural Metals, Atlantic City. See CONF-660607.

The creep-rupture properties of W-25Re alloy irradiated at reactor ambient temperature to fast neutron fluences of 1 to 4×10^{19} neutrons/cm^2 (E_n > 1 MeV) have been determined for test temperatures in the range of 800 to 1100°C. Irradiation tended to decrease the minimum creep rate and increase the time to rupture in this postirradiation test temperature range. It is shown that testing irradiated specimens at 1100°C significantly reduces the rupture ductility. The stress dependency of the creep process in the 900 and 1000°C tests of the irradiated and the control specimens was not appreciably changed. A pronounced change in the stress dependency of irradiated specimens tested at 800°C was observed. The effect is interpreted as a significant change in the nature of the irradiation-induced defect configurations which do not dissociate at temperatures below 900°C and on their subsequent interaction with mobile dislocations. Transmutation effects which occur in W25-Re irradiated in thermal neutron spectrums are discussed. In particular, the production of Os atoms and their effect on the flow stress is considered. (auth)

19604 CRYOGENIC RADIATION EFFECTS ON NERVA STRUCTURAL MATERIALS. Lombardo, J. J. (Space Nuclear Propulsion Office, Cleveland); Dixon, C. E.; Begley, J. A. pp 625-52 of Effects of Radiation on Structural Metals. Philadelphia, American Society for Testing and Materials, 1967.

From 3rd International Symposium on the Effects of Radiation on Structural Metals, Atlantic City.. See CONF-660607.

The NERVA engine environment and material property requirements are discussed. Cryogenic radiation tests performed on structural alloys in support of the NERVA Program are presented. Eleven alloys were irradiated in liquid H_2 to an average dose of 5×10^{18} nvt (E > 1.0 MeV). These alloys, which were tested in tensile and shear in the postirradiation condition prior to warmup, include the A356-T6, 6061-T6, and 7075-T6 aluminum alloys; Types 347 and A-286 stainless steels; Hastelloy C, Inconel X-750, and Inconel 713-C nickel-base alloys; and Ti-5Al-2.5Sn ELI titanium alloy. The D-979 nickel-base alloy and Type 410 stainless steel were tested in shear only. Most alloys showed small but significant changes in one or more properties, with the two cast alloys, Inconel 713-C and Type A356, being most affected. Notched tensile strengths were relatively insensitive to this dose level. Three alloys decreased in shear strength. Although aluminum

alloys are insensitive to radiation damage at ambient and higher temperatures, their sensitivity to damage at cryogenic temperatures is comparable to that of the other alloys. Six alloys were irradiated in liquid nitrogen to neutron doses between 5×10^{17} and 1×10^{18} nvt (E > 1.0 MeV). These alloys were tension-tested without warmup in the postirradiation condition at 140 R. In addition, all alloys were annealed at room temperature for several days and later tested at 140 and 540 R. Selected alloys were annealed and tested at various temperatures up to 1750 R. The alloys tested in tension included the 2219-T6 aluminum alloy. Type 301 cold-worked, and Type 303 Se annealed-bar stainless steels, the nickel-base Inconel 718 and Inconel X-750 alloys, and Ti-5Al-2.5Sn ELI titanium alloy. Radiation effects were noted in all materials on testing without warmup. Partial or complete recovery of properties occurred at 540 R for all specimens. Marked differences, were observed in the behavior of sheet and bar stock in 2219-T6 aluminum and Inconel 718. The influence of test temperature and test atmosphere is discussed, and recommendations are made regarding future radiation-testing variables for obtaining engineering design data. (auth)

19605 EFFECTS OF IRRADIATION ON PHASE TRANSFORMATIONS IN THE Al-RICH Cu SYSTEM. Katz, Lewis Emanuel. Philadelphia, Univ. of Pennsylavnia, 1967. 178p.

Thesis.

An investigation has been carried out on the effects of high energy irradiation on decomposition of supersaturated Al-rich Cu alloys. Samples in the reverted condition were irradiated with deuterons, and both quenched and reverted samples were irradiated with neutrons with doses up to 1.2×10^{17} n/cm². High-dose neutron irradiations were performed on quenched 4% alloys which were subsequently aged to bring out θ'. Zone formation in the deuteron and low-dose neutron experiments was examined by means of electrical resistivity. Specimens subjected to high dose irradiations were examined by x-rays and electron microscopy. Deuteron irradiations near liquid nitrogen temperature of reverted samples resulted in no apparent enhanced rate of nucleation. Apparently, the defects as generated by the irradiations do not contribute to the diffusivity of solute atoms to zones. Neutron irradiations of reverted samples likewise do not alter the rate of zone formation. An acceleration of precipitate formation is observed in the 1% alloy, though this effect saturates at low doses (1.8×10^{14} n/cm²). A model has been formulated to explain the results. There is calculated to be 2.0 times as many effective nucleation sites in the irradiated samples as compared with the unirradiated samples. These sites are thought to be due to spikes. High-dose neutron experiments result in precipitate (θ') formation in the 4% alloy. X-ray and electron microscope photographs are presented. Calorimetric experiments were carried out in an effort to detect an enhanced energy release during zone formation in an irradiated alloy. It is concluded that if any enhanced energy release is occurring, it is less than 6×10^{-3} cal/g min., the sensitivity of the instrument. It is concluded that the precipitation of heterogeneously nucleated precipitates (θ') can be enhanced by neutron irradiation. (Disser. Abstr.)

Ceramics and Cermets

Corrosion and Erosion

19606 INHIBITING EFFECT OF CHLORINE OR CARBON TETRACHLORIDE ON GRAPHITE OXIDATION. Asher, R. C.; Kirstein, T. B. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 25: 344-6(1968).

Additions of small amounts of chlorine or of carbon tetrachloride were made to a nitrogen–oxygen mixture and their inhibiting effects on the oxidation of graphite recorded. Introduction of chlorine caused an immediate drop in temperature, almost as if the oxygen supply had been cut off. However, oxidation was not completely inhibited. Carbon tetrachloride appeared to be an even more efficient inhibitor and the effect seemed more permanent. (M.C.G.)

19607 SOME OBSERVATIONS ON Zr–O SOLID SOLUTIONS WITH A MICROPROBE AND BY ELECTRON MICROSCOPY. Ericsson, T.; Ostberg, G.; Lehtinen, B. (Aktiebolaget Atomenergi, Stockholm). J. Nucl. Mater., 25: 322-7(1968).

Zirconium was oxidized at 700°C for 1000 hr and at 850°C for 160 hr. The oxygen penetration into the metal was measured with an electron microprobe and within the experimental accuracy it was found that the oxygen diffusion obeys the normal diffusion equation with concentration-independent diffusion constant. The hardness was measured in the diffusion zone and the non-linear relation between hardness and oxygen concentration was derived. A plateau at a composition corresponding to Zr_3O was found. The presence of the ordered phase Zr_3O in thin foils of oxidized zirconium was established by selected area diffraction. The dislocation density increased during the oxidation and the new dislocations had very little mobility. (auth)

Preparation and Fabrication

Refer also to abstract 19654.

19608 (BAW-3714-5) GEL-ADDITION PROCESS CHEMICAL STUDIES. Quarterly Progress Report No. 5, July–October 1967. Dewell, E. H. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Feb. 1968. Contracts AT(30-1)-3714; 59-3100. 59p. Dep. CFSTI.

Development of the Gel-Addition process for mixed plutonia-urania reactor fuels has continued. Various contacting techniques were tested for injecting plutonium into UO_2 gel spheres. Agitated-batch tests showed that 800-micron spheres are mechanically strong enough to withstand gentle agitation; contacting at 54°C does not materially increase the total pickup of hexavalent plutonium. Packed-column tests showed increased pickup of hexavalent plutonium with repeated contacting. A 20-gram bed of UO_2 gel was built up to 12% (Pu/U + Pu) by contact with three fresh samples of 0.92 M Pu(VI) at pH ≈ 4. The bed was dried between contacts. Oxidation was severe. Organic residues from the gelation process do not interfere strongly with plutonium pickup. EDTA complexometric titration and coulometric titration gave good agreement on the plutonium assay of U-Pu mixed solutions. Organic interference in plutonium coulometry can be eliminated by boiling the platinum electrode in nitric acid. A shakedown of the apparatus is complete for particle characterization by subsieve particle size determination, density determination by mercury and gas pycnometry, tap density measurement, particle crush strength determination, differential thermal analyses, and sorbed gas measurement. Ceramographic examination of unfired gel is used routinely to establish proper desiccant conditions for gel formation. Autoradiography on organic thin films has shown that Pu(VI) tends to remain on the sphere surface while Pu(III) permeates the entire sphere. The capsule design and the safety analysis for reactor testing of mixed fuels are complete. Initial exposure will verify thermal and nuclear calculations. The irradiation program is under revision. All sol and gel preparation work has been transferred to a new task, which is intended to establish a pilot plant capability for industrial production of $(U,Pu)O_2$ particulate fuel. The mixed sol approach will be used. (auth)

19609 (NYO-3713-3) STUDIES OF THE PREPARATION OF MIXED CARBIDE FUEL UTILIZING COPRECIPITATION. Final Report, May 23, 1966–February 28, 1967. McMurtry, C. H. (Carborundum Co., Niagara Falls, N. Y. Research and Development Div.). Apr. 15, 1967. Contract AT(30-1)-3713. 25p. Dep. CFSTI.

A study was made of the synthesis of (U,Pu)C compounds utilizing the coprecipitation of the carbon and metal-bearing materials from a common solvent. It was demonstrated that near stoichiometric $(U_{0.8}Pu_{0.2})C$ could consistently be made by this process with mixed U, Pu nitrate solution and sucrose as starting materials. A typical carbide product so produced was single phase (U,Pu)C with a lattice parameter of $a_0 = 4.964 \pm 0.001$ Å containing 4.75 percent total carbon and 0.14 percent oxygen. Important process variables included the nitrate-sucrose ratio, pH during coprecipitation, coprecipitation, and low temperature heat treatment as well as the final reaction time and temperature. In the study of process variables, UC was synthesized from uranyl nitrate and sucrose. Essentially stoichiometric UC was prepared with a typical product containing a major phase of UC with a lattice parameter of $a_0 = 4.961 \pm 0.002$Å, a total carbon content of 4.83 percent and 0.09 percent oxygen. (auth)

19610 (RFP-900) MATERIALS FOR HIGH-TEMPERATURE METAL-MELTING CONTAINERS. Meier, Wendell P. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Feb. 21, 1968. Contract AT(29-1)-1106. 11p. Dep. CFSTI.

A method is described for developing pressure-sintering techniques for use in the fabrication of high-temperature metal-melting containers. The pressure-sintered materials included tungsten, zirconium diboride, and various oxides, nitrides, and carbides. These materials were formed into containers of high density and low porosity by pressure sintering. (auth)

19611 CRYSTALLOGRAPHIC CHARACTERISTICS OF CARBONS DERIVED FROM CELLULOSE AND HEMI-CELLULOSE. Kellett, E. A.; Richards, B. P. (General Electric Co., Wembley, Eng.). J. Appl. Chem. (London), 18: 55-60(Feb. 1968).

It is shown that, although such carbons normally exhibit little crystal development, the presence of impurities at the calcining

stage catalyses the graphitization process. X-ray examination indicated that the high degree of directional orientation present in the untreated fibers is not carried over into the carbon material produced by heat treatment. Results of electron microscope and x-ray small-angle scattering studies were used to demonstrate the existence of a complex pore structure, which changes with temperature of heat treatment. Crystal thermal expansion results indicate a large coefficient perpendicular to the layer planes, comparable in magnitude with observations in graphitic carbons. This, together with helium density measurements, indicates that the crystallites in cellulose carbons consist essentially of graphite-like layers in a "turbostratic" stack. (auth) (UK)

19612 PREPARATION OF URANIUM NITRIDES FROM URANIUM TETRACHLORIDE. Mitamura, Takashi; Kanno, Masayoshi; Mukaibo, Takashi (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 60-4(Feb. 1968).

A study was made of UN preparation by two-step reactions with UCl_4, Al, and N_2 gas. In the first step, an intermediate uranium nitride with an N/U ratio of 1.68 resulted from the reaction of UCl_4 with Al under constant flow of N_2 at reaction temperatures higher than 800°C. The x-ray pattern of the intermediate nitride did not correspond to any previously known uranium nitride. A maximum conversion efficiency of about 70% was obtained at 800 to 1,000°C for the first reaction. In the second reaction, the intermediate nitride was heat treated under vacuum. To obtain single phase UN from the intermediate nitride, the heat treatment required a temperature of at least 1,100°C, at which the minimum holding time was 60 min. (auth)

19613 APPLICATION OF TUNGSTEN CARBIDE BY PERCUSSION. Zentner, H. T Z Prakt. Metallbearb., 60: 688-90 (Oct. 1966). (In German).

The percussion welding method is used to apply a coating of tungsten carbide to tools of high-speed tool steel. As in spark erosion, the discharge is instantaneous and within an interval of several thousandths of a second. The coating fuses with the base metal in a metallurgical bond and the tool retains the toughness and strength properties of the tool steel and acquires the hardness and wear resistance of tungsten carbide. The life expectancy and temperature resistance of the workpiece is thus substantially increased. The hardness of 64 R of a conventional high-speed steel is retained ordinarily to a temperature of 550°C., while the same hardness is retained by a carbide-coated steel to an edge temperature of 1150°C. The technique of the application and the apparatus are described in detail and various applications listed. A particular advantage is that the use of carbide tools becomes possible in situations where such applications are desirable but where the configuration is such that carbide tools cannot be shaped suitably by conventional methods. (Rev. Metal Lit.)

19614 CHARACTERISTIC FEATURES OF THE SINTERING PROCESS OF HARD ALLOYS FOR STEEL TURNING. Radu, S. I.; Zamfirescu, C. Cercet Met., 8: 709-17(1966). (In Rumanian).

The manufacturing technique of WC + TIC + TaC type hard alloys is compared with that of tungsten carbide hard alloys. The practical results obtained with the above materials are reported. (Rom. Sci. Abstr.)

19615 THERMAL DISINTEGRATION OF BASIC ZIRCONIUM SULFATE. Lainer, A. I.; Kolenkova, M. A.; Pavlova, V. V.; Nazirov, A. Kh. Tsvetn. Metal., No. 1, 71-2(Jan. 1968). (In Russian).

Studies of thermal disintegration of zirconium sulfate at 850, 1000, and 1200°C showed that it is possible to obtain technically pure zirconium dioxide by annealing the basic sulfate for 4 to 5 min at 1200°C. (R.V.J.)

19616 THE HYDROTHERMAL GROWTH OF BERYLLIUM OXIDE SINGLE CRYSTALS. Hill, V. G.; Harker, R. I. (Tem-Pres Research, Inc., State College, Pa.). J. Electrochem. Soc., 115: 294-8(Mar. 1968).

Beryllium oxide crystals weighing up to 1.3 g were grown hydrothermally with the nutrient temperature at 530 ± 5°C and the growth temperature at 500 ± 5°C. An alkali hydroxide solution of 4N KOH and 0.06N LiOH was used as the hydrothermal solvent. Growth occurred in the vapor phase above the solution. The quality of the seeds used had a major effect on the quality of the crystals grown. The mean growth rate parallel to the c-axis was 0.0026 in./day, but rates of over 0.0056 in. were measured. The relative growth rates in the various crystallographic directions are [11.0] > [00.1] ~ [00.$\bar{1}$] > [11.1] > [10.1] > [10.0]. The effects of the seed orientation on the quality of the crystals produced are [10.1] ~ [11.1] > [11.0] ~ [10.0] > [00.1] ~ [00.$\bar{1}$]. It is the positive pyramidal termination that is nucleated and grown on the seed. (auth)

19617 THE SYNTHESIS OF $UO_{2.37}$ AT HIGH PRESSURE. Hoekstra, H.; Siegel, S.; Charpin, P. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 30: 519-23(Feb. 1968).

Experiments at high pressure established the existence of the compound $UO_{2.37\pm0.02}$. Its crystal symmetry is monoclinic and the cell parameters are a = 5.37$_8$, b = 5.55$_9$, c = 5.37$_1$ Å, and β = 90.29°. The compound was prepared from mixtures of UO_2 and U_3O_8 at 30 to 40 kbars and 500 to 1400°C. The measured density of $UO_{2.37}$ was 11.34 g/cm^3. The ir spectrum is shown to resemble that of UO_2 rather than U_3O_8. (auth) (UK)

19618 METHOD FOR PRODUCING A CERAMIC NUCLEAR FUEL MATERIAL. Ueda, Yoshihiro (to Hitachi Ltd.). Japanese Patent 1967-8120. Apr. 3, 1967. Filed Dec. 10, 1963.

Uniformly blended UO_2 and PuO_2 powders can be obtained in a continuous manner. An organic or inorganic solution of plutonium nitrate (which is a spent fuel) is continuously added to the uranium oxide powder by spraying or other means. These two are passed through a heated region in the presence of a reducing gas or a mixture of reducing and inactive gases, while the two are shaken together, in order to thermally decompose and reduce them. The resultant product is uniformly blended UO_2 and PuO_2 powders. (NSA of Japan)

19619 METHOD FOR PRODUCING A CERAMIC FUEL ELEMENT. Hirose, Yasuo (to Hitachi Ltd.). Japanese Patent 1967-8519. Apr. 14, 1967. Filed Nov. 2, 1963.

A ceramic fuel element, having a high heat-conductivity, can be produced economically. In producing a high-density ceramic fuel element by packing UO_2 powder into the cladding tube, a portion or all of the smallest size UO_2 particles are replaced with the same size particles of a material whose melting point and heat conductivity are high. (NSA of Japan)

19620 METHOD FOR PRODUCING SPHERICAL CERAMIC PARTICLES FOR THE HIGH DENSITY VIBRATION PACKING. Noro, Kenji (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-10601. June 9, 1967. Filed Sept. 21, 1963.

By the method proposed, spherical ceramic particles of a desired particle-size distribution, particularly suitable for nuclear fuel, can be easily produced. Into a plasma flame is inserted a plurality of particle-material rods, having different diameters; the (insertion) velocity of each rod is inversely proportional to its diameter. The fused spherical particles are ejected forward by the force of the plasma flame. (NSA of Japan)

Properties Evaluations

Refer also to abstracts 18796, 19007, and 19666.

19621 (AAEC/TM-402) THE TEMPERATURE AND POROSITY DEPENDENCE OF THE MODULUS OF RIGIDITY AND POISSON'S RATIO OF BERYLLIA. Kelly, J. W.; Whatham, J. F. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aug. 1967. 11p. Dep.

Using torsional equipment designed for the task, the modulus of rigidity of isostatically pressed and sintered beryllia was determined as a function of temperature and porosity. The temperature dependence was given by $G_t = G_{20}(1-at)$, where G_t is the modulus at t°C, G_{20} is the modulus at 20°C and a is a constant approx. 3×10^{-5} deg C independent of porosity up to 800°C. Porosity dependence was given by $G_t = G_0(1-bP)$, where G_0 is the modulus at zero porosity, P is the fractional volume porosity and b is a constant approx. 1.58 independent of temperature up to 800°C. Poisson's ratio was found to be 0.30 ± 0.05 and was independent of both temperature and porosity. (auth)

19622 (CEND-3107-324) BURNABLE POISON ADDITIONS TO UO_2. Period Covered: May 1-September 30, 1967. Zuromsky, G.; Christopher, S. S. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Oct. 1967. Contract AT(30-1)-3742. 30p. (EURAEC-1975). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Studies have been conducted on UO_2-1 wt % B_4C pellets sintered at 625 to 1250°C in argon to investigate the oxidation behavior of B_4C and mode of boron losses. The uranium dioxide powder initially contained 2000 ppM adsorbed moisture and excess oxygen (O/U ratio = 2.16). The data indicated that boron losses involved consecutive reactions by which B_4C was partially oxidized to form intermediate boron oxides at all sintering temperatures. The boron oxides were subsequently removed as volatile products from the pellets. A UO_2-B_4C reaction was initiated at 1200°C by the formation of uranium boride (UB_4). Changes in the microstructures of pellets sintered over the range of temperatures provided an insight into the manner of B_4C oxidation and the nature of boron losses during the sintering process. It is concluded that a dry,

oxygen-free sintering atmosphere is a basic requirement for the preparation of high density UO_2 pellets containing controlled amounts of boron. (auth)

19623 (CEND-3107-328) BURNABLE POISON ADDITIONS TO UO_2. Period Covered: October 1–December 31, 1967. Zuromsky, G.; Christopher, S. S. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.). Jan. 1968. Contract AT(30-1)-3107. 32p. (EURAEC-1990). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

A series of sintering studies has demonstrated that boron is lost from the UO_2 pellets by consecutive reactions including the oxidation of B_4C to form boron oxides which are subsequently removed as volatile products. UO_2 pellets containing 0.05 wt % and 1 wt % B_4C retained 50 percent (±10%) of the initial boron contents during sintering at 1400 to 1600°C. The boron is present as uniformly dispersed particles of uranium borides (UB_4 and UB_2) throughout the sintered UO_2 pellets. The UO_2–0.05 wt % B_4C pellets were sintered to densities of 90 to 93 percent of theoretical in argon and vacuum environments. (auth)

19624 (CONF-650513-10) ^{133}Xe DIFFUSION IN URANIA SOLID SOLUTIONS. Lichtenberger, D. R. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). [1965]. Contract AT(40-1)-2847. 25p. (GE-TM-65-4-40). Dep. CFSTI.

From American Ceramic Society, Annual Meeting, Philadelphia.

Isothermal post-irradiation experiments were performed to measure the release of ^{133}Xe from anion deficient $4UO_{2.3} \cdot Y_2O_3$, $UO_{2.2} \cdot 1.5Y_2O_3$, and $UO_{2.2} \cdot Y_2O_3 \cdot ZrO_2$ solid solution powders. The experiments were conducted in vacuum at 900 to 1350°C for periods up to 900 hours. Assuming simple diffusion from uniform spheres, analysis of the kinetic results yielded values of diffusion coefficients and activation energies that were essentially the same for the three compositions studied. Since the anion-vacancy concentration was significantly different in each composition (oxygen-to-metal ratios 1.7 to 2.0) but the diffusion parameters were nearly the same, it was concluded that xenon does not migrate along the anion sublattice. The magnitudes of the activation energies for xenon diffusion in urania solid solutions (90 to 100 kcal/mole) are larger than those generally reported for rare gas diffusion in UO_2 alone. Observed deviations from simple diffusion kinetics in results of long term anneals on $4UO_{2.3} \cdot Y_2O_3$ were consistent with the proposed model of MacEwan and Stevens who suggested some immobilization of xenon in vacancy clusters or submicron pores and, further, offered the possibility of some xenon re-entry back into the lattice. (auth)

19625 (GEAP-4879) THE THERMAL CONDUCTIVITY OF URANIUM AND URANIUM–PLUTONIUM OXIDES. Hetzler, F. J.; Lannin, T. E.; Perry, K. J.; Zebroski, E. L. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Aug. 1967. Contract AT(04-3)-189. 32p. Dep. CFSTI.

The thermal conductivities of $UO_{1.97}$ to $UO_{2.01}$ and (0.2 Pu-0.8 U)$O_{1.98}$ to (0.2 Pu-0.8 U)$O_{2.05}$ were studied at 800 to 1900°C. Sintered pellet thermal conductivities were measured with thermal gradients typical of operating reactor fuel. Gradients from 450 to 3000°C cm were typical. The results of these measurements indicate that the thermal conductivity of mixed oxide decreases with increasing temperature from 800 to 1900°C; stoichiometric mixed oxide and UO_2 of 95% theoretical density have similar thermal conductivities at 1000 to 1900°C. Below 1000°C, the thermal conductivity of UO_2 is higher. (The values measured for stoichiometric UO_2 in this work are in general agreement with those found in the literature.); and the thermal conductivity of hypostoichiometric UO_2 is higher than that of stoichiometric material at low temperatures but decreases rapidly to coincide with the conductivity of stoichiometric material at a temperature region which corresponds to dissolution of liquid uranium in the urania lattice. (auth)

19626 (IS-1632) MECHANICAL STRENGTH OF MIXTURES OF MAGNESIUM OXIDE AND CALCIUM FLUORIDE FROM ROOM TEMPERATURE TO 1000°C. Calderwood, F. W.; Wilder, D. R. (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 29p. Dep. CFSTI.

The effect of additions of calcium fluoride on the hot load strength of a refractory grade of magnesium oxide was studied. Specimens were prepared by powder-pressing rectangular bars, shaping the bars with a reduced cross-section at the mid-point, and finally, sintering the bars at 1800°C under a helium atmosphere in a molybdenum resistance furnace. Fired specimens were stressed to failure by the cross-bend method under an oxidizing atmosphere in a globar furnace. Several specimens were tested at each temperature-composition point, and the resulting data were treated by statistical methods. Specimens containing no calcium fluoride were found to have greatest resistance to rupture at temperatures of 500°C and below. Between 500 and 1000°C, results were more erratic, but specimens usually showed greater strength with the increase of calcium fluoride up to 8 mole %. At 1000°C, the specimens with no additive again showed greater strength. It was postulated that the silica impurity in the magnesia caused the formation of small amounts of glass which, at the higher temperatures, decreased in viscosity as the calcium fluoride content increased. A relatively high viscosity at the intermediate temperatures contributed to resistance to fracture, but at higher temperatures an increase of fluidity caused rapid failure of the specimens. (auth)

19627 (LA-tr-67-112) IMPREGNATED TANTALUM CARBIDE. Hivert, Andre. Translated for Los Alamos Scientific Lab., N. Mex., from Mem. Sci. Rev. Met., 64: 77-92(1967). 39p. (CONF-651091-1). Dep. CFSTI. JCL $3.60 fs, $1.37 mf.

From Fall Meeting of the French Society on Metallurgy, Paris, France.

This paper was abstracted from the original language and appeared in NSA as 21: 20574. (L.C.L.)

19628 (WAPD-Trans-83) CONTRIBUTION TO THE STUDY OF OXYGEN SELF-DIFFUSION IN REFRACTORY OXIDES: APPLICATION TO UO_2. Contamin, Pierre; Stefani, Rene (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from report CEA-R-3179. 29p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

This paper was abstracted from the original language and appeared in NSA as 21: 34953. (L.C.L.)

19629 MAGNETIC PROPERTIES OF UP_2–UAs_2 SOLID SOLUTIONS. Trzebiatowski, Wlodzimierz; Misiuk, Andrzej (Inst. of Low Temperature and Structure Research, Wroclaw). Rocz. Chem., 42: 163-4(1968).

The solid solutions were prepared by heating stoichiometric mixtures of uranium powder with the appropriate quantities of arsenic and phosphorus. Magnetic measurements were carried out by the Faraday method at 85 to 370°K. The lattice constants showed positive deviations from linearity and all samples preserved the antiferromagnetic transformation of the compounds. (M.C.G.)

19630 INVESTIGATION OF THE SYSTEM La_2O_3-Yb_2O_3 AND OF THE CRYSTAL STRUCTURE OF $LaYbO_3$. Mueller-Buschbaum, H.; Teske, C. (Justus Liebig Univ., Suedanlage, Ger.). Inorg. Nucl. Chem. Lett., 4: 151-2(Mar. 1968). (In German).

Heat treatment of $La_2O_3 \cdot Yb_2O_3$ at 1600 and above 2000°C indicated a fairly broad range of composition for the existence of the perovskite $LaYbO_3$ (in contradiction to previous data), and a relatively narrow range for the Yb_2O_3-rich cubic phase (in agreement with previous data). A detailed x-ray study was made of $LaYbO_3$ single crystals, and values are given for the lattice constants, space group, and coordinates of the atoms. (UK)

19631 PHYSICAL AND MECHANICAL PROPERTIES OF BLENDED AND BALL-MILLED ALUMINIUM–ALUMINIUM OXIDE ALLOYS. Hansen, N. (Danish Atomic Energy Commission, Riso). J. Nucl. Mater., 25: 334-6(1968).

The physical and mechanical properties of blended and ball-milled Al–Al oxide alloy are discussed. Five points are criticized and the conclusion reached that it is possible to produce a homogeneous Al–Al oxide having better mechanical properties by a combination of blending and ball-milling than commercial SAP. This conclusion is not in agreement with the presented data. (F.S.)

19632 USE OF ZIRCONIUM OXIDE CERAMIC DIE NIBS FOR HOT EXTRUSION OF METALS. Ind. Heating, 34: 526; 528; 530; 532(Mar. 1967).

High-quality refractory metal round extrusions have been produced at 3000°F and pressure above 200,000 psi in zirconium oxide hot extrusion dies. The oxide is tough, dense and highly resistant to thermal shock and has higher strength than any previous zirconium oxide body. It also has improved wear and corrosion resistance, particularly against glasses. Dies are not wet by most molten metals, are inert to strong chemicals (except HF and molten caustic) and have low thermal conductivity and specific heat. They give excellent surface finish and appear to reduce dimensional variations along the extrusion. Typical applications include low-carbon steel rod, brass rods and billets, Cu–Ni alloys, copper phosphor bronze, 98Cu–2Si alloy, Nb rod, Mo alloy, stainless steel and W. (Rev. Metal Lit.)

19633 SINTERING OF THORIA POWDERS. IV. DEVELOPMENT OF CRYSTALLINITY IN THORIA POWDERS DURING HEATING AND ITS INFLUENCE ON THEIR SINTERING BEHAV-

IOR. Moorthy, V. K.; Eswara, Prasad G.; Kulkarni, A. K. (Atomic Energy Establishment, Trombay, India). Trans. Indian Ceram. Soc., 24: 103-11(1965).

Thoria powders of different origins and thermal history have different sintering characteristics. The difference in the sintering behavior can not be completely accounted for by the physical characteristics of the powder. The development of crystallinity with rise in temp. was studied in case of thoria powders prepared at 600°C from oxalate, carbonate and tannate, and those derived from the compd. in situ, using a high temp. x-ray camera. Marked differences in crystallinity were noticed for powders of different origins and for those of the same origin but subjected to different calcination treatments. The shapes of the particles of different origins and calcination treatments were studied by electron microscopy. An attempt has been made to explain differences in the sintering behavior of thoria, of different origins and thermal history, on the basis of the crystallinity of the powders. (Indian Sci. Abstr.)

19634 INVESTIGATION OF CRACKS AROUND THE VICKERS INDENTATION IN CEMENTED CARBIDES. Miyoshi, Akiyoshi; Hara, Akio; Sugimoto, Yoshinobu (Sumitomo Electric Industries, Ltd., Itami, Japan). Nippon Kinzoku Gakkaishi, 31: 1123-6(1967). (In Japanese).

Effects of lapping on the crack length around the Vickers indentation were examined in various cemented carbides. And then, to analyze the lapping effect, the dependence of micro-hardness on lapping time was studied with the same specimens and WC single crystals. It was found that a remarkable dependence of the crack length on lapping time in ordinary cemented carbides having the WC phase. On the contrary, no dependence was shown in (W, Ti, Ta) C–Co alloys with no WC phase; as for the microhardness, the same tendency as the crack length was shown in WC single crystals, a considerable dependence of micro-hardness on lapping time was shown on the basal plane; by measuring the micro- and macro-hardness of cemented carbides under various test loads, it was shown that the depth of several microns of the surface was hardened by lapping; and from the results obtained, the dependence of the crack length on lapping time may be explained by the work hardening of the WC phase during lapping. (auth)

19635 WEAR RESISTANCE OF CEMENTED CARBIDES. Fukatsu, Tamotsu; Yuhara, Kazuhiko; Kobori, Keiichi (Toshiba Tungaloy Co., Kawasaki, Japan). Nippon Kinzoku Gakkaishi, 31: 1127-32(1967). (In Japanese).

The wear resistance of cemented carbide is usually estimated from the hardness, but it is often inadequate to interpret the practical problems only from the hardness. The relations between the wear resistance and the properties of WC–Co sintered alloys which were prepared by varying the cobalt content, particle size of WC powder, small addition of TaC and sintering temperature were studied. The wear resistance was measured from the flank wear land produced by the turning of cement-mortar, gray cast iron and carbon steel. Generally, as mentioned previously, the wear resistance increased with increasing hardness and coercive force or decreasing cobalt content and WC grain size of the alloys. The wear resistance increased linearly with decreasing WC grain size of the alloys in spite of the particle size of the WC powder used as raw material. However, the relations between hardness or coercive force and wear resistance were affected by the particle size of the WC powder; that is, both hardness and coercive force were the same, but the wear resistance of the alloys made of coarse WC powder was better than that of fine WC powder. Such a difference in wear resistance by the particle size of the WC powder was more remarkable in the turning of gray cast iron than that of cement-mortar. The effect of a small addition of TaC was observed in the turning of steel, but not in the turning of the cement-mortar or gray cast iron, and the effect of the grain size of the WC powder of the alloys was predominant in the latter. (auth)

19636 CO-EQUILIBRIUM PRESSURE OF NIOBIUM–OXYGEN SOLID SOLUTIONS. Fromm, Eckehard; Spaeth, Gernot (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 59: 65-8(Jan. 1968). (In German).

The dependence of the CO-equilibrium pressure over niobium on temperature and on the content of dissolved oxygen and carbon has been determined at 1600 to 1900°C. The enthalpy of solution of carbon monoxide in niobium is −67 kcal/mol CO. The experimentally observed CO-equilibrium-pressures follow the relation $p_{CO} \sim c_{C,O}^{2}$ and don't prove exactly the Sieverts $\sqrt{p}$-law. In the temperature range of the experiments the terminal solubility of the Nb–C–O-solid solution with the C/O-ratio 1 lies between 0.2 and 0.7 mol-% CO. At temperatures above 1900°C the equilibrium is distributed by the evaporation of volatile oxides. (auth)

19637 A MASS SPECTROMETRIC STUDY OF THE BeO–BeF_2 SYSTEM AT HIGH TEMPERATURES. Efimenko, J. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 72A: 75-80(Jan.-Feb. 1968).

Mass spectrometric studies were made at high temperatures of the vapors over BeF_2(s) and BeO(s) individually and of their mixture. The sublimation enthalpy, $\Delta H_0^0 = 55.56 \pm 0.43$ kcal/mol, where 1 kcal equals 4184 j, was obtained for BeF_2 by the use of a log I^+T versus $1/T$ plot. A complex molecule appeared in the $BeF_2 \cdot BeO$ system at high temperatures which, on the basis of its m/e position, corresponded to Be_2OF_2. For the reaction, $BeO(s) + BeF_2(g) = Be_2OF_2(g)$, a second law treatment of the data gave an enthalpy value, $\Delta H_1^1 = 41.56 \pm 1.8$ kcal/mol. The data, combined with free energy functions, resulted in a mean reaction enthalpy, $\Delta H_1^0 = 42.6$ kcal/mol. The heat of formation for $Be_2OF_2(g)$, $\Delta H_f^0 = -288.3$ kcal/mol, was computed using the reaction enthalpy based on the second law. (auth)

19638 TRACER STUDY OF THE SURFACE DIFFUSIVITY OF UO_2. Marlowe, M. O.; Kaznoff, A. I. (General Electric Co., Pleasanton, Calif.). J. Nucl. Mater., 25: 328-33(1968).

The surface self-diffusion coefficient D_s for uranium ions on polycrystalline $UO_{2.00}$ was measured at 1544 to 1915°C. A radioactive tracer technique employing diffusive spread of uranium from a UO_2 point source on a planar UO_2 surface was used. The radial distributions of diffusing atoms after diffusion anneals were analyzed to determine the diffusion coefficients. The surface diffusion coefficient was observed to obey the relationship $D_s = 5.64 \times 10^7 \exp(-120{,}700/RT)$ cm²/sec. (auth)

19639 STUDY ON THE QUARTERNARY ALLOYS OF IRON AND BORON. Hasegawa, Masayoshi; Okamoto, Masafumi (Tokyo Univ.). Nippon Kinzoku Gakkaishi, 31: 1314-20(1967). (In Japanese).

In order to find the properties of carbon-free iron-boron quaternary alloys containing both ferrite-soluble elements (Ni, Cr, Mn) and boride-forming elements (Nb, Mo, Ti), investigations have been made on the peritectoid temperature, microstructure, heat treatment characteristics, mechanical properties, etc. The boron contents in the specimens were 0.10 and 0.20%. The results are summarized as follows: (1) The Fe-B quaternary alloys were hardened due to the fine precipitation of alloy boride by annealing treatment. Nb had a refining effect on the ferrite grain size on Fe-B alloys, especially on alloys of the Fe-B-Ni system. (2) The Fe-B quaternary alloys containing proper amounts of Nb or Mo air-cooled from the γ-region exhibited jagged and irregular interfaces. The hardness of the structure with these interfaces was higher than that of the polygonal ferrite formed in an annealing condition. (3) In the Fe-B quaternary alloys water-quenched from the γ-region, the acicular structure supersaturated with boron appeared. This structure was formed more easily with increasing austenitizing temperature, and moreover the hardness of the alloys increased linearly with it. (4) By tempering after water-quenching, Fe-B quaternary alloys exhibited high resistance to softening up to 600°C and a slight peak of hardness at 500 to 600°C. At about 700°C the hardness fell rapidly to a level of polygonal ferrite, and this was associated with recrystallization of matrix and coalescence and growth of the precipitates. (5) Some Fe-B quaternary alloys air-cooled and quench-tempered had a high tensile strength of 55 to 65 kg/mm²; especially, Fe–0.1% B–3% Ni–0.55% Nb alloys showed excellent strength, ductility and toughness. (auth)

19640 EFFECTS OF THE CARBON CONTENT ON THE SURFACE INTERACTION BETWEEN WC–10 PERCENT Co CEMENTED CARBIDES AND CARBON STEELS. Suzuki, Hisashi; Yamamoto, Takaharu; Kawakatsu, Ichiro (Tokyo Univ.). Nippon Kinzoku Gakkaishi, 31: 1248-53(1967). (In Japanese).

Interdiffusion phenomena between WC-10% Co alloys and carbon steels were examined in relation to their carbon contents. Two kinds of cemented carbides, i.e., low carbon and high carbon two-phase alloys were coupled and brazed at 1100° to 1300°C for 1 hr with steels having various carbon contents. Then, hardness measurements, microstructure observations and x-ray analyses were made on the diffusion layers. Main results obtained were as follows: (1) As for the diffusing direction of carbon, the mechanism which is generally accepted that carbon diffuses from cemented carbides to steels was not always confirmed. The inverse diffusion from steels to cemented carbides was observed when the carbon content of steels exceeded about 0.8%. (2) Complex carbide was formed in the cemented carbide side, only when the diffusing direction of carbon was from cemented carbides to steels. The carbide was identified to be M_6C type. (3) It seems that the properties of cemented carbides are deteriorated due to the following facts; (i) Harmful phases, i.e., M_6C, $M_{23}C_6$ or free carbon phase, were formed in cemented carbides according to the coupling conditions.

(ii) Cobalt diffused from cemented carbides and at the same time iron diffused in; and (4) the diffusing amount of cobalt or iron appeared to be strongly affected by the carbon contents of coupled materials. (auth)

19641 THERMODYNAMIC PROPERTIES OF SOME CALCIUM NIOBATES. Dneprova, V. G.; Rezukhina, T. N.; Gerasimov, Ya. I. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 178: 135-7(Jan. 1, 1968). (In Russian).

The $CaO-Nb_2O_5$ system was investigated. The phase diagram studies were carried out by preparing a series of mixtures of pure $CaCO_3$ and Nb_2O_5, containing 10 to 95 mole % of CaO. The compacts were heated for 35 to 40 hours at 800 to 1400°C in zirconium dioxide boats. The 2 phases found by x-ray diffraction studies in the 0 to 50 mole % range, Nb_2O_5 and CaO. Nb_2O_5 agreed with earlier findings; on the other hand, the compound $2CaO \cdot Nb_2O_5$ was not identified. The phase diagram work did not include quenching tests; thus this phase may exist at higher temperatures as was indeed shown by electrochemical studies. The preliminary emf measurements revealed that in the presence of niobates at 1100 to 1300°K equilibrium, emf is established without catalysts; addition of Cr_2O_3 and $K_2Cr_2O_7$ catalysts at those temperatures depresses the emf. The thermodynamic properties of $CaO \cdot Nb_2O_5$ and $2CaO \cdot Nb_2O_5$ at 1100 to 1400°K such as entropy and the heat of formation, were calculated from the emf data of the $Pt,O_2/CaO/CaF_2/CaO \cdot Nb_2O_5 + Nb_2O_5/Pt,O_2$ cell. (TTT)

19642 MODIFIED CARBIDE FUELS. (to Westinghouse Electric Corp.). British Patent 1,104,775. Feb. 28, 1968. Priority date Sept. 7, 1965, United States.

The composition of a nuclear metal carbide fuel is discussed. The fuel contains uranium, plutonium, or plutonium–uranium carbide with small predetermined proportions of Cr or chromium carbide, or both. The design of a nuclear fuel element is given comprising stainless steel cladding, the carbide fuel, and liquid metal such as sodium or NaK disposed in the cladding and filling the space around the body of fuel. (J.C.W.)

19643 INTERSTITIAL ALLOYS. Goldschmidt, H. J. London, Butterworths, 1967. 638p. 200s.

The subject is treated under the following sectional headings: introduction; metal physics of interstitial alloys; interstitial solid solutions; carbides; nitrides; borides; silicides; oxides; hydrides; mixed interstitial compounds; appendix-interstitial matter: some wider aspects. (UK)

19644 NUCLEAR SCIENCE AND TECHNOLOGY FOR CERAMISTS. Proceedings of the American Ceramic Society Symposium, Washington, D. C., April 7–12, 1966. National Bureau of Standards Miscellaneous Publication 285. Washington, D. C., National Bureau of Standards, 1967. 71p. GPO $1.75. (CONF-660461).

A total of six papers is presented which includes: radiation environment, radiation damage, physical properties of irradiated ceramic materials, chemical problems associated with lattice defects, nuclear fuel materials, and design of reactor materials. Separate abstracts have been prepared for all the papers. (P.G.C.)

For abstracts of individual papers see: 19645, 19646, 19659, and 19676–19678.

19645 NUCLEAR FUEL MATERIALS. Readey, D. W.; Handwerk, J. H. (Argonne National Lab., Ill.). pp 45-60 of Nuclear Science and Technology for Ceramists. Washington, D. C., National Bureau of Standards, 1967.

From American Ceramic Society Symposium, Washington, D. C. See CONF-660461.

Selection of a nuclear fuel material is dependent upon many compromises of material properties consistent with demands of the power generating system. Those properties which dictate the use of a given material for specific systems such as thermal and fast reactors, nuclear rocket engines, and direct conversion devices, are reviewed. Materials of interest are uranium, plutonium and thorium and their compounds either alone or combined with each other or with non-fissile materials. Technology at the present time is directed toward the utilization of primarily the oxides and carbides of fissile metals. However, their nitrides, sulfides, and phosphides show promise as potential fuel materials but the properties of these compounds must be more fully delineated before they can be considered for fuel purposes. (auth)

19646 REACTOR MATERIALS DESIGN. de Halas, D. R.; Morgan, W. C.; Freshley, M. D. (Battelle Northwest, Richland, Wash.). pp 61-71 of Nuclear Science and Technology for Ceramists. Washington, D. C., National Bureau of Standards, 1967.

From American Ceramic Society Symposium, Washington, D. C. See CONF-660461.

Design problems in the use of graphite as structural and moderator materials in a nuclear reactor are discussed. The type of graphite to be used is controlled by the service temperature and type of atmosphere. Dimensional stability under irradiation is controlled by graphite structure. Effects of radiation damage, service temperature and atmosphere on the use of beryllium oxide are outlined. A summary of the several types of irradiation damage to nuclear control materials is given. Engineering aspects of ceramic fuel element design are used as a basis for discussion of materials-coupling problems in reactor design. Stresses introduced by changes in the core often cause clad failure. Compatibility between the core and clad material, and effects of impurities in the core as acting on the clad, are also important. Service conditions affect the choice of materials, due to effects on performance of failed fuel elements, corrosion, and fission gas release. (auth)

19647 SURFACE PROPERTIES OF TITANIA POWDERS. Hanson, Martin B. Alfred, N. Y., Alfred Univ., 1967. 149p.

Thesis.

An interrelated series of experiments has been performed on high surface area titania powders to determine what effect niobium doping has on the chemical and electrical constitution of these powders. These experiments included surface area, electrical conductivity, and magnetochemical measurements. An observed ac frequency dependence of the Arrhenius temperature coefficient of electrical resistance required development of an equivalent circuit technique for separation of conduction data into high and low frequency components, and yielded clearer insight into the actual sources of electrical conduction. The general characteristics determined for the powders studied is that vacuum reduction of pure titania powders creates oxygen vacancies and an accompanying number of Ti^{+3} ions. In the case of niobium doping the presence of Ti^{+3} ions was reduced. The oxidizing effect of niobium on oxygen vacancies was suggested as a possible cause of this effect. Magnetic susceptibility measurements indicated electron spin pairing in niobium doped anatase powders. (Disser. Abstr.)

Structure and Phase Studies

Refer also to abstracts 19558 and 20384.

19648 (EUR-3739) SOME CONSIDERATIONS ON THE INFRARED ABSORPTION SPECTRUM OF PuO_2 POWDERS AND SINTERED PELLETS. Manes, L.; Barisich, A.; Buijs, K. (European Atomic Energy Community, Karlsruhe (West Germany)). 1968. 24p. Dep.

Infrared absorption measurements have been performed on PuO_2 powders and sintered pellets in the spectral range of 4 to 50 μ Å resonance frequency have been found at 360 ± 10 cm^{-1}, attributable to one-phonon fundamental absorption ("Reststrahlen" absorption). On the short wave length side of this absorption band a detailed structure is found, attributable to many-phonon combinations. A remarkable similarity is found between the spectrum of PuO_2 and those of UO_2 and ThO_2. A discussion is given of the effect of sizes and shapes of the crystals on the one-phonon resonance frequency, in the light of recent theories. (auth)

19649 (NUMEC-3505-30) $PuO_2-UO_2-ZrO_2$ FUEL DEVELOPMENT PROGRAM. Progress Report, April 1–June 30, 1967. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Nov. 1967. Contract AT(30-1)-3505. 42p. (EURAEC-1946). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

Irradiation testing of six ternary fuel compositions in the $PuO_2-UO_2-ZrO_2$ system was continued and post-irradiation examination was begun. The fuel system has potential application for plutonium recycling in thermal reactors now fueled with slightly enriched uranium such as Pressurized Water Reactors and Boiling Water Reactors. Phase diagram studies and melting point measurements were performed and reference samples were analyzed for oxygen-to-metal ratios and carbon content. (F.S.)

19650 REACTION OF TITANIUM SUBOXIDE AND ZIRCONIA. Glazova, V. V.; Kornilov, I. I. Zh. Neorg. Khim., 12: 3159-62 (1967). (In Russian).

The phase equilibrium in the system Ti_3O-Zr_3O was studied. Melts were prepared in an arc furnace with a tungsten electrode under helium from titanium and zirconium iodides and from their oxides containing 15.8 and 10.17 wt % oxygen, respectively. Crystal and microstructures were studied on etched surfaces and chemical composition and physical properties were determined. The existence of an eutecticum over the concentration range of 5 to 25 at. % Zr was established, with transition to single phase composition. All alloys in the studied range of the ternary system are brittle and not usable for practical applications. The range of

solid solutions based on Zr_3O with a mainly covalent bond type is markedly larger than that based on Ti_3O with metallic type bonds. This phenomenon differs from the usually observed conditions and is not explained. (ATD)

19651 STUDIES ON THE $mNb_2O_5-nNa_2O$ SYSTEM. II. THE CASE OF $m/n > 1$. Bouillaud, Yvette (CNRS, Bordeaux). Bull. Soc. Chim. Fr., No. 1, 112-17(Jan. 1968). (In French).

A semiquantitative radiocrystallographical analysis following an accurate qualitative analysis (with an internal standard) indicates that the only stoichiometric compounds occurring in the system $mNb_2O_5-nNa_2O$ ($m/n > 1$), investigated at 1200°C, are the niobates $NaNb_3O_8$ and $NaNb_{15}O_{33}$. On the other hand the occurrence of a solid solution derived from sodium metaniobate by difficiency in Na_2O is also pointed out, it has the probable composition limit $Na_{0.900}NbO_{0.950}$. (auth)

19652 THE STRUCTURE OF $Y_{0.33}TaO_3$, $La_{0.33}TaO_3$. Trunov, V. K.; Lykova, L. N.; Afonskii, N. S. Vestn. Mosk. Univ., Ser. II. Khim., No. 1, 55-8(Jan.-Feb. 1968). (In Russian).

The structures of $Y_{0.33}TaO_3$ and $La_{0.33}TaO_3$ were determined. Interatomic distances and atomic coordinates are given. (auth)

19653 CHANGE OF COMPOSITION OF $UC_{1-x}N_x$ IN NITROGEN GAS. Kai, Hiroshi; Katsura, Masahiro; Sano, Tadao (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 43-7(Feb. 1968).

The UC–UN solid solution, $UC_{1-x}N_x$, exists stably in monophase within a certain range of nitrogen pressure at constant temperature. At the upper limit of this range, $UC_{1-x}N_x$ coexists with UC_2 or with carbon, and it precipitates metallic uranium at the lower limit which corresponds to the decomposition pressure of $UC_{1-x}N_x$. In order to measure the decomposition temperature of $UC_{1-x}N_x$ with given x under constant nitrogen pressure, it is necessary to heat $UC_{1-x}N_x$ without changing its composition, at a constant pressure. Preliminary considerations were given to change in composition. Experiments were also performed in which the solid solution was heated at a rate of 200°C/min under different nitrogen pressures. From the results, it was concluded that there exists a temperature range within which the value of x in $UC_{1-x}N_x$ is maintained constant when the nitrogen pressure is fixed. (auth)

19654 MONOCARBIDES OF URANIUM DEFICIENT IN NONMETALS: COMPOSITION AND LATTICE PARAMETERS. Boncoeur, M.; Accary, A. (CEN de Saclay, Gif-sur-Yvette, France). J. Nucl. Mater., 25: 271-7(1968). (In French).

It has been experimentally established that there is a deficit in carbon and oxygen in uranium monocarboxide prepared at 1600°C in the presence of excess uranium. The formula is to be represented as $UC_xO_y\square_t$, where $\square$ denotes a vacancy. The mean value of carbon and oxygen deficiency is $t = 0.05 \pm 0.03$, and the limiting oxygen solubility is about 0.35 oxygen atom per uranium atom, that is, the same ratio as in stoichiometric monocarboxides. For a fixed oxygen content, the deficient monocarboxides have smaller lattice parameters than the stoichiometric monocarboxides, so long as oxygen saturation has not been reached. This difference in parameter can be interpreted in terms of the missing carbon and oxygen atoms if one assumes that oxygen has its covalent atomic radius. (auth)

19655 COORDINATE RELATIONS IN ZINC NIOBATE AND ZINC TANTALATE. Kasper, Horst (Univ., Bonn). Z. Anorg. Allg. Chem., 355: 1-11(Nov. 1967). (In German).

In the systems $ZnO-Nb_2O_5$ and $ZnO-Ta_2O_5$ the phases $Zn_3Nb_2O_8$ (I) and $Zn_3Ta_2O_8$ (II) exist. Substituting some Zn in (II) by Co, Ni or Cu the structure changes from (II) to that of (I). The light absorption of Co^{2+}, Ni^{2+}, Cu^{2+} in these phases is investigated. Therefrom it is deduced that the bivalent cations in (II) occupy octahedral and tetrahedral sites, but in (I) only octahedral ones. (tr-auth)

19656 RESEARCH ON PHASE TRANSFORMATION OF MONOCLINIC B- TO HEXAGONAL A-TYPE IN MONOCRYSTALS OF RARE EARTH OXIDES. Mueller-Buschbaum, Hk. (Justus-Liebig Univ., Giessen, Ger.). Z. Anorg. Allg. Chem., 355: 41-51 (Nov. 1967). (In German).

On adding 24 to 27 mol % La_2O_3, the transition of B- to A-type Sm_2O_3 starts at 2300°C. Single crystal x-ray work shows that this transition is no one-step reaction but proceeds continuously. Both forms present in one single crystal are strictly 3-dimensionaly orientated during the transition. (auth)

19657 STRUCTURAL ANALYSIS ON Cr_2O_3-OXIDIZING CATALYST MIXTURES. III. ZrO_2/Cr_2O_3. Lesnikowitsch, A. I.; Ebert, I.; Scheve, J. (Lenin-Univ., Minsk. Institut fuer Physikalische Chemie, Berlin. Institut fuer Anorganische Katalyseforschung, Berlin). Z. Anorg. Allg. Chem., 355: 52-63(Nov. 1967). (In German).

The system $ZrO_2-Cr_2O_3$ has been investigated up to 16 mol % Cr_2O_3. The crystal structure of ZrO_2 depends on the amount of added Cr which is inserted into the lattice as Cr^{5+} and Cr^{3+}. (tr-auth)

19658 PRELIMINARY INVESTIGATIONS IN THE HIGH-SILICA REGION OF THE SYSTEM $BeO-Al_2O_3-SiO_2$. Ganguli, D.; Saha, P. Trans. Indian Ceram. Soc., 24: 134-46(1965).

The nature of the liquidus surface in the high-silica region of the system $BeO-Al_2O_3-SiO_2$ was investigated by the quenching technique. One ternary eutectic (1515° ± 5°) and two reaction points were located. The primary phase fields determined were those of bromellite, chrysoberyl, phenacite, mullite and silica. Beryl was obtained by subsolidus reactions at temperatures very close to the eutectic, but the possibility of the presence of a very small primary phase field for beryl could not be ruled out altogether. (Indian Sci. Abstr.)

19659 CHEMICAL PROBLEMS ASSOCIATED WITH LATTICE-DEFECTS. URANIUM DIOXIDE PHASE. Thorn, R. J.; Winslow, G. H. (Argonne National Lab., Ill.). pp 33-44 of Nuclear Science and Technology for Ceramists. Washington, D. C., National Bureau of Standards, 1967.

From American Ceramic Society Symposium, Washington, D. C. See CONF-660461.

The role of lattice defects in non-stoichiometric chemical phases is reviewed and discussed. Aspects considered are: roles of valence-states and their energies, basic elements of the defect theory of non-stoichiometry, thermodynamic equilibrium, and self diffusion. Particular attention is given to the possible application of the theories to non-stoichiometric uranium dioxide insofar as they may explain some of the processes involved in its sintering. (P.G.C.)

19660 REGION OF GLASS-FORMATION IN THE As–Se–Cu SYSTEM. Savan, Ya.; Kozhina, I. I.; Borisova, Z. U. Vestn. Leningrad. Univ., Ser.-Fiz. Khim., No. 10, 141-4(May 1967). (In Russian).

The dissociation of U_3O_8 at 10^{-4} to 10^{-5} mm Hg was investigated at 300 to 900°C. The uranium oxides of different composition were subjected to chemical and x-ray analyses to establish phase ratios. The high-temperature x-ray investigation of uranium oxides was carried out at 300 to 1100°C. The rhombic phase resulting from the decomposition of U_3O_8 is established to be in the composition range $UO_{2.662}$ to $UO_{2.695}$. Besides this phase there is a fluorite phase in the uranium oxides with a lesser oxygen index. (tr-auth)

19661 RATIO OF GRAIN BOUNDARY TO SURFACE ENERGY FOR URANIUM CARBIDE. Hodkin, E. N.; Nicholas, M. G.; Poole, D. M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 25: 284-7(1968). (AERE-R-5557).

The ratio of the grain boundary energy to the solid surface energy for stoichiometric uranium carbide has been calculated from the median grain-boundary groove angles produced at 1100 to 1600°C in argon atmospheres. The extreme values of the ratio are 0.355 and 0.407; the average ratio for all the individual grooves is 0.377 which is close to that found for many fcc metals. (auth)

19662 INFLUENCE OF BORON CONTENT ON THE FINE MICROSTRUCTURE OF PYROLYTIC GRAPHITE. Katz, R. N.; Gazzara, C. P. (Army Materials and Mechanics Research Center, Watertown, Mass.). J. Mater. Sci., 3: 61-9(Jan. 1968).

A study of the fine microstructure of boronated pyrolytic graphite was made utilising optical and x-ray diffraction techniques. The influence of boron content on the laminar structure, the lattice parameter, the lattice strain, the particle size, and the flexural strength of pyrolytic graphite was studied. Significant changes in the behaviour of all investigated parameters were observed in the 0.50 to 0.75 wt % boron range. A mechanism relating these changes to the appearance of a boron carbide deposit is hypothesised. (auth)

19663 THE BINARY SYSTEM $HfO_2-Gd_2O_3$. Spiridinov, F. M.; Stepanov, V. A.; Komissarova, L. N.; Spitsyn, V. I. (Moscow State Univ.). J. Less-Common Metals, 14: 435-43(Apr. 1968).

Phase relationships in the $HfO_2-Gd_2O_3$ system were studied by thermal and x-ray analysis and the phase diagram of the system was plotted. The existence of a compound $Gd_2Hf_2O_7$, with a pyrochlore structure [a = 10.490 Å] was established. This compound melts congruently at 2440°C. Solid solutions based on the pyrochlore-type compound are, on each side of the stoichiometric composition, transformed into fluorite-type solid solutions. Two hexagonal compounds of an M_7O_{11} type were found in the Gd_2O_3-rich region (>50 mol % Gd_2O_3), viz., $Gd_{5.25}Hf_{1.75}O_{11.375}$, which possesses a very narrow range of homogeneity, if formed at about 60 mol % Gd_2O_3, and Gd_6HfO_{11}, which is formed within the

Gd_2O_3 concentration range between 75 and 90 mol % Gd_2O_3. The first of these compounds undergoes a transformation at 1500°C into a cubic solid solution of fluorite C-type, and the second at 1700°C into a cubic solid solution in C–Gd_2O_3. (auth)

19664 PHASE RELATIONS BETWEEN PALLADIUM OXIDE AND THE RARE EARTH SESQUIOXIDES IN AIR. McDaniel, C. L.; Schneider, S. J. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 72A: 27-37(Jan.-Feb. 1968).

The equilibrium phase relations were determined in an air environment between PdO and each of the following: La_2O_3, Nd_2O_3, Sm_2O_3, Eu_2O_3, Gd_2O_3, Dy_2O_3, Ho_2O_3, Y_2O_3, Er_2O_3, Tm_2O_3, Yb_2O_3, and Lu_2O_3. In air PdO dissociates to Pd metal at 800°C. The dissociation of PdO is apparently a reversible process. The Nd_2O_3–PdO and Sm_2O_3–PdO systems were studied in detail inasmuch as they typified several of the Ln_2O_3–PdO systems. Three compounds, $2Nd_2O_3 \cdot PdO$, metastable $Nd_2O_3 \cdot PdO$, $Nd_2O_3 \cdot 2PdO$ occur in the Nd_2O_3–PdO system. The 2:1, 1:1, and 1:2 compounds, of unknown symmetry, dissociate or decompose at 1135, 860, and 1085°C, respectively. The 2:1 compound dissociates to the solid phases, Nd_2O_3 and Pd. No further reactions occur between Nd_2O_3 and Pd up to 1300°C. Three compounds, 2:1, metastable 1:1, and 1:2 occur in the Sm_2O_3–PdO and Eu_2O_3–PdO systems. Two compounds, 2:1 and 1:2 occur in the La_2O_3–PdO system. Other compounds detected were the 1:1 and 1:2 in the Gd_2O_3–PdO system and the metastable 1:1 in the Dy_2O_3–PdO system. Each of these compounds subsequently dissociated upon heating. No apparent reaction occurred between PdO and either Ho_2O_3, Y_2O_3, Er_2O_3, Tm_2O_3, Yb_2O_3, or Lu_2O_3. (auth)

19665 URANIUM–URANIUM MONOARSENIDE PHASE DIAGRAM. Benz, Robert; Tinkle, M. C. (Los Alamos Scientific Lab., N. Mex.). J. Electrochem. Soc., 115: 322-4(Mar. 1968).

Uranium-uranium monoarsenide phase boundaries were deduced from thermal analyses and from x-ray diffraction and microscopic analyses of quenched products. The uranium–uranium monoarsenide eutectic occurred at 1125 ± 5°C with a composition near pure uranium. Uranium solubility in the UAs phase did not exceed 0.15%. The highest melting point observed with the UAs (+U) phase was 2705°C. (auth)

19666 A DIAGRAM OF THE SYSTEM STATE Eu_2O_3–Cr_2O_3. Shevchenko, A. V.; Lopato, L. M.; Yaremenko, Z. A. (Inst. of Problems in Studies of Materials, Tashkent). Dopov. Akad. Nauk Ukr. RSR, Ser. B, No. 10, 925-8(1967). (In Russian).

A diagram of the system state Eu_2O_3–Cr_2O_3 was studied at 1600 to 2400°C. A congruent melting compound, europium chromite and two eutectics, formed by this compound with Eu_2O_3–Cr_2O_3 were found in the investigated system. Some physicochemical properties of europium chromite were determined. (auth)

19667 TERNARY Zr–V–C AND Hf–V–C SYSTEMS. Voroshilov, Yu. V.; Fedorov, T. F.; Gorshkova, L. V. Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 154-6(Jan. 1968). (In Russian).

Isothermal cross sections of the phase diagrams constructed for ternary Zr–V–C and Hf–V–C systems were investigated at 1000°C. (R.V.J.)

19668 ANALYSIS OF CRYSTAL GROWTH OF HIGH TEMPERATURE MATERIALS IN A PLASMA FURNACE. Smith, William Austin. Gainesville, Fla., Univ. of Florida, 1966. 153p.

Thesis.

An analysis of the crystal growth mechanism of refractory materials taking place in the fireball of a plasma-heated Verneuil-type furnace is given. The fireball temperature is estimated at well over 9,000°K. Such parameters as the powder feed rate, thermal gradient at the liquid-solid interface, rf power level, powder grain size, geometry of the boule tip with respect to the powder probe and fireball, powder-gas flow rate, and the presence of a diatomic gas are investigated and their effects of crystal growth and quality are determined. It was found that the large radiation heat loss from the side of the boule dominates the thermal conditions during crystal growth. When the rf power is low, the boule is cool and the thermal gradients are large. As the boule increases in length, the rf power must be boosted in order to maintain a molten cap. If the power were not boosted the molten cap would eventually vanish as the boule grew longer, at which point all growth would stop. The large radiant heat losses from the side of the boule are not always as important as was found in the case of growing aluminum oxide crystals. If materials of a lower melting point are involved, radiation losses become less important. If materials of higher melting points are involved, clearly the importance of the radiation losses becomes much more critical. The dramatic increase in the heat transfer rate from the plasma when diatomic gases are used constitutes an important improvement. The effect of loss of heat due to the introduction of fine powder grains into the plasma is another observation not originally anticipated. It was further found that the parameters important to crystal quality are the ratio of the thermal gradient at the liquid-solid interface to the powder feed rate and the average temperature of the molten cap. Crystal quality was generally better at the periphery than at the core of a boule. It is concluded that the work reported on contributes to a more effective use of the plasma-Verneuil furnace in growing crystals of refractory materials. (Diss. Abst.)

Radiation Effects

19669 (BNWL-624, pp 2.1-32) FUELS DEVELOPMENT. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Batch Core Experiments provided irradiation behavior of PuO_2–UO_2 fuel elements operated at power generations greater than that employed in power reactors in determining behavior and failure behavior of PuO_2–UO_2 and UO_2 fuels under out of limit transient conditions. The low Pu concentrations used in vibrationally compacted PuO_2–UO_2 produced about the same behavior as that of UO_2. Samples from Shippingport and Yankee fuel heavy elements were analyzed in determining radiation hazards to establish shielding needs for Pu fabrication. A test was conducted in the Fuel Element Test Facility to gain experience with fuel assemblies containing hot pressed pellets. An analytical model was used to determine the influence of plant throughput on thermal reactor fuel element costs. Cost estimates of ¼ and ½ ton/day output levels for fuel elements enriched with U and high exposure Pu were compared with previously estimated cost for producing the same fuels at an output of 1 ton/day. The trend of increasing internal gas pressure with exposure has been found with instrumented PuO_2–UO_2 rods being used in measuring fuel rod gas pressure and plenum gas temperature. Physical changes as a result of irradiation are being studied for defected vibrationally compacted UO_2 fuel rods with 60 to 65% of the radii molten at defect locations. In a test of water meltdown behavior of nonirradiated Zircaloy-clad vibrationally compacted UO_2 fuel rods with and without simulated fission gas pressure, pressure rise rates of compacted UO_2 rod were higher than those resulting from the meltdown of pellet-containing fuel rods. Underwater examination of irradiated UO_2 and PuO_2–UO_2 fuel elements indicates that their performance continues to be satisfactory. (F.S.)

19670 (BNWL-624, pp 6.1-20) MATERIALS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Flux effects on corrosion and hydriding Zircaloy-2 and -4 tubing in the PRTR were studied. The comparable corrosion properties of Zircaloy-2 and Zircaloy-4 were found to be consistent with the behavior of the two alloys. The superior resistance of Zircaloy-4 to H absorption is typical of the comparative behavior of the alloys. Dissolution characteristics of oxalic-peroxide-gluconic and anhydrous liquid ammonia–sodium metal procedures for ceramic fuel dissolution were determined. Corrosion and B deposition in boric acid solution additives in the heavy water moderator of the PRTR are summarized. Aluminum corrosion was localized in the process shroud-tube bellows assembly. Boron deposition did not exceed 3 $\mu g/cm^2$. A tentative specification for defect detection limits for electronic inspection of PRTR process tubes was prepared. Tests were run at room and elevated temperature on the effect of hydrogen on crack propagation. (F.S.)

19671 (EURAEC-1980) THE SHAPING AND IRRADIATION OF URANIUM MONOCARBIDE. Quarterly Report No. 24, April 1–June 30, 1967. Devillard, J.; Morlot, G. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 29p. (EUR-3779). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The SIL 5 irradiation of 8% ^{235}U enriched uranium carbide was placed in pile with a linear I^2R loss of around 1000 W/cm. From interpretation of the irradiation thermal parameters it may be assumed that the core temperature of the SIL 5 fuel is 1250°C with a thermal gradient in the carbide of 440°C. The E2 irradiation of a 2% ^{235}U enriched uranium carbide pencil is continuing favorably. The 2100 MWd/t burn-up ratio was attained with a linear I^2R loss of 800 W/cm. Construction of the CYRANO capsule is continuing. (auth)

19672 (GEAP-5570) SHORT-TERM FAST FLUX (EBR-II) IRRADIATION OF PuO_2–UO_2 FUEL PINS. Rabin, S. A.; Kendall, W. W.; Baily, W. E. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Oct. 1967. Contract AT(04-3)-189. 70p. Dep. CFSTI.

Results of the initial fast flux irradiation of mixed oxide fuel

pins in EBR-II are described. Major objectives of the test were to obtain data on short-term fuel performance in a fast spectrum and to serve as a precursor to high burnup irradiations. Six encapsulated fuel pins incorporating a variety of design and fabrication parameters were irradiated to a relatively low burnup and examined. All of the specimens behaved satisfactorily, and specimens with target burnups of 50,000 to 100,000 MWd/te were subsequently inserted in EBR-II. (auth)

19673 EXAMINATION OF THE ALUMINA PHASES IN SAP AFTER IRRADIATION. Beghi, G.; Cazzaniga, E. (CCR-EURATOM, Ispra, Italy). Energ. Nucl. (Milan), 15: No. 2, 58-60(Feb. 1968).

The effects of irradiation on the transformation of SAP–Al_2O_3 are described. The Al_2O_3 was taken from a SAP finned tube of an irradiated fuel element. (auth)

19674 IRRADIATION-INDUCED DENSIFICATION OF PYROLYTIC CARBON. Bokros, J. C.; Schwartz, A. S. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-633. Trans. Met. Soc. AIME, 239: 7-13 (Jan. 1967). (GA-7146).

The irradiation-induced densification of pyrolytic carbon has been shown to take place by a simple first-order rate process. The values of the densification constant, k_d, for isotropic carbons are 1.0×10^{-22}, 1.4×10^{-22}, and 2.8×10^{-22} $(nvt)^{-1}$ at irradiation temperatures of 520, 670, and 1000°C, respectively. The apparent activation energy obtained from the temperature dependence of k_d for isotropic carbons is about 0.2 eV. Estimates of the maximum stresses that develop in isotropic carbons owing to shrinkage onto an unyielding support show that stresses in excess of 15,000 psi may be avoided during irradiation at 600 and 1000°C if the initial coating density is kept above 1.5 and 1.9 g per cm^3, respectively. If a carbon coating on an unyielding support is not completely isotropic, stresses may continue to build up at high neutron exposures after densification is complete because of continued anisotropic distortion. Stresses in excess of 15,000 psi from this source may be avoided during irradiation at 1000°C if the Bacon anisotropy factor is kept below 1.3. (auth)

19675 VARIATION OF THE TEMPERATURE DEPENDENCE OF MOBILITY CARRIERS GENERATED BY X RADIATION IN CdS SINGLE CRYSTALS. Korsunskaya, N. E.; Svechnikov, S. V.; Chalaya, V. G. Fiz. Tekh. Poluprov., 1: 488-90(1967). (In Russian).

Measurements were made of the temperature dependence of the Hall mobility of photoelectrons μ_{ph} and electrons μ_x generated by x-radiation in CdS single crystals with In-electrodes in the temperature range from −110° to +130°C. The specimens used (5 × 1 × 0.1 mm) consisted of high-ohmic ($\rho > 10^9$ ohm · cm) photosensitive single crystals obtained by synthesis from the vapor phase. The measurement results were compared with the temperature dependence of mobility when visible light was used for excitation. The magnetic field intensity was 3 kOe. A weakly absorbable light (λ = 5300 Å) and a strongly absorbable light (λ = 4900 Å) were used for measuring the mobility of the photoelectrons. The measurements showed that at room temperature the photoelectron mobility μ_{ph} and the mobility of electrons μ_2 generated by the x-radiation differ by less than 20%. The mobilities did not depend on the intensity of the exciting visible and x-radiation either at room temperature or at lower temperatures. When visible light with λ = 5300 Å was used for excitation in the temperature interval from −110 to 130°C the photocurrent decreased with temperature according to the law $I_{ph} \sim T^{-\alpha}$ (for the majority of crystals $\alpha = 3/2$); the current stimulated by the x-radiation did not depend on the temperature. The mobility of electrons generated by the visible light followed the same law $\mu_{ph} \sim T^{-\alpha}$ as $I_{ph}(T)$. The $\mu_2(T)$ dependence differs from the $\mu_{ph}(T)$ dependence: $\mu_2(T)$ does not depend on temperature and remains constant even in that temperature range where $I_x(T)$ begins to decrease with the decrease of the temperature. (ATD)

19676 MATERIAL RADIATION ENVIRONMENT. Muehlhause, C. O. (National Bureau of Standards, Washington, D. C.). pp 1-6 of Nuclear Science and Technology for Ceramists. Washington, D. C., National Bureau of Standards, 1967.

From American Ceramic Society Symposium, Washington, D. C. See CONF-660461.

Materials used in radiation systems are in general restricted by a wide variety of boundary conditions. For example, in reactor systems the materials are required not only to possess suitable nuclear properties, but also to display adequate stability against radiation damage. Ceramic materials are important in this technology. Radiation fields to which reactor materials are subjected are described, and principal physical effects induced by the radiation are identified. The elucidation of these effects by materials scientists and engineers is important not only to nuclear technology, but also to a general understanding of structure sensitivity of solids. (auth)

19677 FUNDAMENTALS OF RADIATION DAMAGE IN CERAMICS. Lidiard, A. B. (Atomic Energy Research Establishment, Harwell, Eng.). pp 7-20 of Nuclear Science and Technology for Ceramists. Washington, D. C., National Bureau of Standards, 1967.

From American Ceramic Society Symposium, Washington, D. C. See CONF-660461.

Processes of radiation damage in ceramic materials of interest in nuclear technology are reviewed. These materials include those used as fuels (e.g., UO_2 solid solutions) as fuel coatings (e.g., SiC, Al_2O_3) and as moderators (e.g., graphite, BeO). Radiation damage in these materials consists of the production of interstitial atoms and vacancies and, in fuels, of the introduction of foreign atoms notably the fission products. Also, at normal reactor temperatures the aggregation of these defects into clusters occurs and in non-cubic materials this leads to anisotropic changes in physical properties of the component, crystallites of which the most striking may be dimensional changes (e.g., in graphite). In fuels the growth of bubbles of fission gas can also lead to important dimensional changes. The theory of the growth of defect clusters is described in relation to some of these problems. (auth)

19678 PHYSICAL PROPERTIES OF IRRADIATED CERAMIC MATERIALS. Levy, Paul W. (Brookhaven National Lab., Upton, N. Y.). pp 21-32 of Nuclear Science and Technology for Ceramists. Washington, D. C., National Bureau of Standards, 1967.

From American Ceramic Society Symposium, Washington, D. C. See CONF-660461.

Materials are subjected to two principal types or radiation effects during reactor irradiation. First, there are ionization effects which result from electron and (electronic) hole movement and trapping. Second, there are displacement effects resulting from the movement of atoms. Reactor irradiation introduces vacancies, interstitials, and more complex defects consisting of combinations of these simple defects. Some of these act as charge traps. Numerous examples of radiation induced changes in the physical properties of ceramic materials can be cited. The most common phenomena associated with ionization effects is the coloring of glasses by irradiation. Displacement effects occur when atoms are ejected from their lattice sites by energetic electrons, gamma-rays, slow neutrons; fast neutrons (very efficiently); and, rarely, by other radiations. Almost all of the fast neutron damage is caused by energetic lattice atom recoils which are created by elastic collisions with fast neutrons. As the recoil passes through the lattice it produces numerous vacancies and interstitials along its trajectory. Both the ionization effects and the formation of individual point defects are illustrated by color-center studies on very pure fused silica. The defect regions occurring along the trajectory of the lattice atom recoil can be related to changes in the low temperature thermal conductivity in single crystal Al_2O_3. The collective effect of numerous damage-creating events, produced by long irradiations, result in a density decrease in crystal quartz and density increase in fused silica. In addition, the physical properties of materials are changed during irradiation. During bombardment the defect concentration is increased and this will, in turn, increase any defect-dependent diffusion processes. For example, the diffusion of Be in BeO is greatly accelerated during reactor irradiation. (auth)

19679 EFFECT OF NEUTRON IRRADIATION ON CHRYSOBERYL. Jostsons, A.; Hickman, B. S. (Australian Atomic Energy Commission Research Establishment, Sydney). J. Nucl. Mater., 25: 278-83(1968).

Results are presented of studies of single crystals of chrysoberyl ($BeAl_2O_4$) after neutron irradiation to doses up to 3.5×10^{20} nvt > 1 MeV. The macroscopic and x-ray growth were found to be equal both during irradiation and after post-irradiation annealing. The growth tended towards saturation at doses above 1×10^{20} nvt and the lattice growth was anisotropic at all doses. Defect clusters were not observed in thin flakes of irradiated material studied by transmission electron microscopy. Only a limited number of defect loops was observed in material annealed after irradiation. It is concluded that large defect clusters do not usually form in chrysoberyl. The observations on chrysoberyl, both irradiated, and irradiated and subsequently annealed, are compared with previous observations on BeO and Al_2O_3. (auth)

19680 FISSION PRODUCT SEGREGATION AT THE SURFACE OF IRRADIATION UO_2 PARTICLES. Oi, N.; Tanabe, I. (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). J. Nucl. Mater., 25: 288-95(1968).

Slightly irradiated UO_2 particles (single crystals of diameter

0.11 μm) were annealed in various atmospheres at 600 to 1200°C and the fission products which were segregated at the surface of the particles were leached. Of the fission products, molybdenum and barium segregated at the surface, the amounts being 35 to 45% after 10 min annealing in vacuo at 1000°C. The rates of segregation during the initial stages were found to be controlled by diffusion and the diffusion coefficients obtained for molybdenum agreed with data previously reported. Technetium was almost completely volatilized at the higher temperatures. A possible connection between the molybdenum and barium segregation and the composition of inclusions found in highly irradiated UO_2 pellets is suggested. (auth)

19681 THERMAL CONDUCTIVITY OF NEUTRON IRRADIATED Al_2O_3, BeO, AND MgO AT LOW TEMPERATURES. Jaeger, Raymond Edward. New Brunswick, N. J., Rutgers–The State Univ., 1967. 101p.
Thesis.

The thermal conductivity of polycrystalline oxide ceramics at low temperatures is extremely sensitive to the presence of defects of the type induced by fast neutron irradiation. Inasmuch as these materials are used in various engineering applications where they are subjected to different forms of radiation it is of particular interest to determine the kind and extent of damage produced. High density, high purity, polycrystalline specimens of alumina, beryllia and magnesia were exposed in a reactor to integrated flux levels ranging from 5×10^{16} to 1×10^{20} n/cm² (energy > .01 MeV). The thermal conductivity characteristics of the rod shaped samples were determined before and after irradiation in a cell designed to measure conductivity by axial heat flow in the temperature range 30 to 300°K. A phenomenological model for low temperature lattice conductivity has been successfully used to describe both the temperature and frequency dependence of the defect scattering thus identifying the dominant mechanism responsible for phonon scattering in a given material. In aluminum oxide the damage consists of point defects which scatter the lattice waves in the temperature range 90 to 180°K and an additional mechanism responsible for extra resistance in the range 30 to 90°K. Irradiation of beryllium oxide results in the formation of planar sheets of defect clusters scattering according to an ω^{-2} dependence of the relaxation time. Neutron bombardment of magnesium oxide forms dislocations whose associated strain fields scatter phonons with a relaxation time proportional to ω^{-1}. Between 95 and 100 percent of the damage induced by the reactor irradiation in alumina, beryllia, and magnesia is recoverable by annealing in the range from room temperature to 1100°C. (Disser. Abstr.)

Plastics and Other Materials

Refer also to abstract 20830.

19682 (UCRL–13328) A STUDY OF RADIATION-ACCELERATED CREEP IN POLYCARBONATE. Final Report, July 1960–June 1967. Mayer, Robert H.; Hoffman, Allan S. (Massachusetts Inst. of Tech., Cambridge). Contract W-7405-eng-48. 34p. Dep. CFSTI.
For California Univ., Livermore. Lawrence Radiation Lab.

The creep of polycarbonate during irradiation is being investigated. It has been found that the creep rate of polycarbonate is greater during irradiation than before or after irradiation. Similar behavior occurs in other polymeric materials such as polystyrene and polymethyl methacrylate. Unlike the other materials polycarbonate exhibits an induction period during which the creep rate is virtually unaffected by the radiation. A cursory investigation of the effects of temperature, stress, pre-quench treatment, and sample thickness has been made on the creep of polycarbonate. Modifications of the equipment (creep and radiation) have been completed so that more reliable results can be obtained and these results will be amenable to analysis by an Eyring-type rate equation. Density measuring equipment has been constructed. Studies on normal (non-radiation) creep of glassy polymers (polymethyl methacrylate) have shown that density has a very strong effect. Quenching, which affects density, has a considerable effect on creep during irradiation. Creep during irradiation of other polymeric materials has been utilized to study the cause of accelerated creep previously found to be caused by the gases produced during irradiation. Based on this cause polyisoprene would not be expected to exhibit accelerated creep because it is a rubber and thus has a much greater gas permeability than the glassy materials studied, and the gas produced is hydrogen, which has a high diffusivity. As expected polyisoprene exhibits no accelerated creep during irradiation. The mechanism by which gases cause a temporary increase in creep rate is proposed to be that the gases contribute local free at their site of production. To verify the cause of the induction period, polyethylene terephthalate was studied because it has a structure similar to polycarbonate and most of the gases produced during irradiation are given off at sites of high local free volume. The creep curves of polyethylene terephthalate exhibit an induction period during the first few minutes of irradiation. No accelerated creep was observed in cold drawn nylon 6-6 or H-film. High density polyethylene exhibits a discontinuous form of accelerated creep during irradiation. (J.C.W.)

19683 PREPARATION OF WOOD-PLASTIC COMBINATIONS BY IONIZING RADIATION. Miettinen, Jorma K. (Univ. of Helsinki). Paperi Puu-lehdesta, No. 2, 1-11(1967). (In Finnish).

Wood-plastic combinations (WPC) are new experimental products, which are produced by impregnation of wood under vacuum with a liquid raw-material of a plastic (a vinyl monomer), which is then hardened (polymerized) in the pores of the wood by irradiation with penetrating radioactive gamma radiation. The properties of the product mainly depend upon the kind of wood and the kind and amount of monomer used. Leaf trees, especially birch, and the sapwood of pine give good results, but the heartwood of conifers and aspen are incompletely and unevenly impregnated. Most used monomers are methylmetacrylate, vinylacetate and a mixture of styrene and acrylonitrile. There exist commercial products which contain 40% methylmethacrylate. Promising results have been obtained with mixtures of styrene and polyesters. Polymerization of such mixtures and the physical strength of such products are described. Comparison of the use of radiation polymerization with that of chemical catalysts and describes the possible use of WPC in the construction, furniture and sport article industries as well as its estimated cost of production are made. The impregnation and irradiation units of a pilot plant with an annual production of 1,600 tons of WPC are outlined. (auth)

19684 METHOD OF MANUFACTURING HIGH-TEMPERATURE HEAT-INSULATING ARTICLES. Kamenetsky, Solomon Pavlovich (to Vsesojuzny Nauchno-Issledovatelsky I Proektny Inst., Teploproekt). British Patent 1,098,843. Jan. 10, 1968. Filed Jan. 19, 1965.

A process is described for producing from expanded perlite and an aluminous binder, articles having high heat-insulating properties; high temperature resistance; chemical resistance to liquid Na, K, or their alloys; and good neutron stability. The process consists of the following steps: a clay slip is prepared from the aluminous binder, a thinner or peptizing agent is added to the slip, the thinned or peptized slip is mixed with expanded perlite, a thickening or coagulating agent is added, the ingredients are further mixed, the slurry is molded to obtain the article of desired shape, and the article is subsequently dried and fired. (B.L.M.)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 19811, 19853, 19897, 19898, and 20495.

19685 (CONF-670953-1) THE OBSERVATION OF 10- TO 50-keV SOLAR FLARE X RAYS BY THE OGO SATELLITES AND THEIR CORRELATION WITH SOLAR RADIO AND ENERGETIC PARTICLE EMISSION. Technical Report CR-107. Arnoldy, R. L.; Kane, S. R.; Winckler, J. R. (Minnesota Univ., Minneapolis. Cosmic Ray Group). Sept. 1967. 44p.

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary.

More than 70 cases have been observed of energetic solar flare x-ray bursts by large ionization chambers on the OGO satellites in space. The ionization chambers have an energy range between 10 and 50 keV for x rays and are also sensitive to solar protons and electrons. A study was made of the x ray–microwave relation and it was found that the total energy released in the form of x rays between 10 and 50 keV is approximately proportional to the peak or total energy simultaneously released in the form of microwave emission. For a given burst the rise time, decay time, and total duration are similar for the 10- to 50-keV x rays and the 3- or 10-cm radio emission. Roughly exponential decay phases are observed for both emissions with time constants between 1 and 10 minutes. All 3- or 10-cm radio bursts with peak intensity greater than 80 solar flux units are accompanied by an x-ray burst greater than 3×10^{-7} ergs cm^{-2} sec^{-1} peak intensity. The probability of detecting such x-ray events is low unless the radio spectrum extends into the centimeter range of wavelengths. The best correlation between cm-λ and energetic x rays is observed for the first event in a flare. Subsequent structure and second bursts may not correspond even when the radio emission is rich in the microwave component. A very good correlation exists between the occurrence of large SID events (importance – 3) and energetic x rays. The overall correlation for importance 1, 2, and 3 is 55%. Almost 90% of the x-ray bursts were accompanied by known SID events. The mechanism for the energetic x rays is shown to be bremsstrahlung probably of fast electrons on a cooler plasma. The mechanism for the radio emission is basically uncertain. However, if it is assumed to be synchrotron radiation, then a relation is developed between density and magnetic field which meets the observed quantitative results. One finds, on the average, that 5×10^{-54} joules m^{-2} $(CPS)^{-1}$ of microwave energy at Earth are required per electron at the Sun to provide the radio emission for the various events. A strong correlation between interplanetary solar-flare electrons observed by satellite and x-ray bursts are shown to exist. This correlation is weak for solar proton events. One may infer a strong propagation asymmetry for solar-flare electrons along the spiral interplanetary magnetic field. (auth)

19686 EXPLANATION OF THE SYSTEMATIC DISPLACEMENT OF LINES TOWARD THE RED IN THE SYSTEM OF GALAXIES. Malet, Henri. Compt. Rend., Ser. A and B, 266: 209(Jan. 22, 1968). (In French).

Recent studies by de Broglie and Brillouin have shown that the Doppler–Fizeau effect is not necessarily the cause of the displacement toward the red. Reconciliation of the formula $\lambda = cT = c/\nu$ of the relation which gives the energy of the luminous wave $W = h\nu$ shows that the displacement toward the red is the exact counterpart of an energy loss of the wave. This energy loss can be interpreted as being constituted by a very slight scattering of the luminous ray provoked either by the collision of luminous waves from stars of $\lambda = 1$ mm or by the very small material particles which populate the interstellar or intergallactic space. (J.S.R.)

19687 ROTATION OF THE SOLAR WIND PLASMA. Alfonso-Faus, Antonio (Univ. of Minnesota, Minneapolis). Planet. Space Sci., 16: 1-6(Jan. 1968).

The purpose of the work described was to study the effect of the rotation of the Sun on the solar wind. A solution of the angular momentum equation is presented, coupled with Maxwell's equations, that gives the interplanetary magnetic field structure as well as the azimuthal component of the solar wind velocity. The radial magnetic stresses that result because of the interaction are seen to be negligible compared with the radial gradients of pressure; thus the treatment of a radial expansion of the corona neglecting magnetic fields seems to be justified. (auth) (UK)

19688 EXPLOSIVE NUCLEOSYNTHESIS. Wagoner, Robert V. (California Inst. of Tech., Pasadena). Astrophys. J., 151: L103-8(Mar. 1968).

Some results of calculations of element synthesis within bodies which expand rapidly from very high temperatures are presented. It is found that very fast expansions $[V^{-1}dV/dt \gtrsim 10^3\sqrt{(24\pi G\rho)}]$ and initial neutron–proton equality ($|X_p - X_n|_0 \lesssim 0.1$ percent) produce the most realistic abundances. For baryon densities $\rho_b = (10^3 - 10^4)$ $(T/10^{9}K)^3$ g cm^{-3}, these abundances are in qualitative agreement with those observed in the oldest stars, if they contain appreciable helium. In addition, the ratios among the elements and isotopes heavier than boron resemble solar-system abundances. (auth)

19689 RARE GAS CHRONOLOGY OF HYPERSTHENE ACHONDRITES AND PALLASITES. Megrue, G. H. (Brookhaven National Lab., Upton, N. Y. Smithsonian Astrophysical Observatory, Cambridge, Mass.). J. Geophys. Res., 73: 2027-33(Mar. 15, 1968).

Three hypersthene achondrites and olivine from six pallasites were analyzed for potassium and isotopic abundances of helium, neon, and argon. The potassium abundances of these meteorites, except Johnstown, were found to be much lower than previously reported. K–Ar ages of the hypersthene achondrites are $\geq 3.2 \times 10^9$ years. Three pallasites have concordant K–Ar ages of 4.3×10^9 years, and three gave anomalous results. ^3He, ^{21}Ne, and ^{38}Ar radiation ages of the hypersthene achondrites are concordant at 20×10^6 years. Radiation ages of the pallasites vary from 25×10^6 to 205×10^6 years. Heating of these meteorites after crystallization has been negligible. (auth)

19690 RADIO MEASUREMENT OF THE ATMOSPHERIC OZONE TRANSITION AT 101.7 GHz. Caton, W. M. (Chico State Coll., Calif.); Mannella, G. G.; Kalaghan, P. M.; Barrington, A. E.; Ewen, H. I. Astrophys. J., 151: L153-6(Mar. 1968).

The successful detection and preliminary line-profile resolution of the $4_{0,4} \rightarrow 4_{1,3}$ atmospheric ozone transition at 101.737 GHz in both the absorption and emission spectrum of the Sun are reported. The search for this particular line resonance was prompted by the anticipated higher intensity relative to previously detected lines, leading to a shorter integration time and ability to resolve the line profile. (W.D.M.)

19691 MARS, JUPITER, AND SATURN: 3.4-MM BRIGHTNESS TEMPERATURES. Epstein, Eugene E. (Aerospace Corp., El Segundo, Calif.). Astrophys. J., 151: L149-52(Mar. 1968).

The 3.4-mm brightness temperatures of Mars, Jupiter, and Saturn are 167° ± 20°, 140° ± 16°, and 130° ± 15°K. These values have been compared with the other available millimeter brightness temperatures. The uncertainties of the available data are too large to permit any statistically significant statements about variations with wavelength of the millimeter brightness temperatures of Mars, Jupiter, and Saturn. (auth)

19692 RECENT OUTBURST OF RS OPHIUCHI. Code, Arthur D. (Univ. of Wisconsin, Madison). Astrophys. J., 151: L145-7(Mar. 1968).

During the recent outburst of the recurrent nova RS Ophiuchi several spectrograms were obtained 11 and 13 days after maximum, covering the spectral region from λ3500 to λ5100 Å. The spectrum appears to be substantially the same as that exhibited, at this stage, during the previous outbursts in 1933 and 1958. Radiative ionization and excitation by photons longward of the hydrogen Lyman continuum provide a satisfactory explanation of all the broad emission lines present on these spectrograms. In addition to the broad lines, sharp components are present, presumably produced by an outer shell. (auth)

19693 CRITICAL REMARK ON COX'S OPACITY TABLES. Baerentzen, Joern (Univ. of Aarhus, Denmark). Astrophys. J., 151: L143-4(Mar. 1968).

In view of the extensive use which is made of Cox's tables of opacity (1965), it was thought appropriate to point out an error occurring in the formalism concerning the free–free part of the absorption coefficient. (W.D.M.)

19694 SYNCHROTRON RADIATION FORMULAE. Scheuer, P. A. G. (Cambridge Univ., Eng.). Astrophys. J., 151: L139-42(Mar. 1968).

In a recent letter, Epstein and Feldman (1967) pointed out that the usual formulae for synchrotron radiation, as derived by Westfold (1959) and by LeRoux (1961), do not give the correct value for the radiated power received from a highly relativistic electron spiraling around a magnetic field with pitch angle $\psi = \pi/2$. They give revised formula, which differ from the generally accepted ones by a factor of $\sin^2 \psi$. Up to this

point, the author would agree that they have made a valid statement. However, they go on to conclude that most of the theoretical work which has been done with the conventional formulae requires reinterpretation. The author believes that the latter idea is based on a misunderstanding and offers various remarks in support of his belief. (W.D.M.)

19695 RADIO PROPERTIES OF THE ELLIPTICAL GALAXIES NGC 1052 AND NGC 4278. Heeschen, D. S. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 151: L135-8(Mar. 1968).

All available flux-density measurements are shown. The 21-cm measurements were made with the 300-ft telescope, and the 11-, 6-, and 2-cm measurements with the 140-ft telescope. The spectra are sufficiently well determined to show that they are much flatter than the normal spectra of extragalactic sources and that the spectrum of NGC 1052 has a positive slope at the shorter observed wavelengths. Both galaxies were observed with the 3-element interferometer at various baseline lengths. (W.D.M.)

19696 DETECTION OF HARD X RADIATION FROM VIRGO. Haymes, R. C.; Ellis, D. V.; Fishman, G. J.; Glenn, S. W.; Kurfess, J. D. (Rice Univ., Houston, Tex.). Astrophys. J., 151: 131-4(Mar. 1968).

The detection at balloon altitudes of hard x rays from the Virgo region is reported. Other groups have previously reported the detection of a weak flux of soft x rays from M87 with rocket-borne instruments. The present experiment has found evidence, at the 99% confidence level, for a discrete source of photons with energies up to 107 keV in the direction that is either associated with the quasar 3C 273, or, somewhat more likely, M87. (W.D.M.)

19697 DETECTION OF GAMMA RADIATION FROM THE CYGNUS REGION. Haymes, R. C.; Ellis, D. V.; Fishman, G. J.; Glenn, S. W.; Kurfess, J. D. (Rice Univ., Houston, Tex.). Astrophys. J., 151: L125-9(Mar. 1968).

The detection at balloon altitudes of gamma radiation from the Cygnus region is reported. Hard x rays have previously been measured from several discrete sources in this region of the sky by various groups. The present experiment has, in addition, detected radiation at energies up to 453 keV and has also been able to find the differential energy spectrum of the hard x rays and gamma rays. (W.D.M.)

19698 POSSIBLE IDENTIFICATION OF LAC X-1 WITH THE WOLF-RAYET BINARY HD 211853. Wallerstein, George (Univ. of Washington, [Seattle]). Astrophys. J., 151: L121-4(Mar. 1968).

The close-binary, Wolf-Rayet star HD 211853 may be an x-ray source if its expanding shell is the result of a hot corona. The possibility that other close binaries or Wolf-Rayet stars may emit x rays is discussed, with particular reference to the similarity in galactic distribution between x-ray sources and Wolf-Rayet stars. (auth)

19699 OF AND WOLF-RAYET STARS AS X-RAY SOURCES. Bless, R. C.; Fischel, D.; Stecher, T. P. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 151: L117-19(Mar. 1968).

The envelopes surrounding Of and Wolf-Rayet stars are considered as possible thermal x-ray sources; in particular, ζ Pup and/or γ_2 Vel are suggested to be the source Vel XR-1. (auth)

19700 DYNAMICAL THEORY OF VISCOUS TIDES IN CLOSE BINARY SYSTEMS. Roach, Gary F. (Univ. of British Columbia, Vancouver). Astrophys. Space Sci., 1: 32-67(Jan. 1968).

Quantitative aspects of the phenomenon of tidal lag in close binary systems, the components of which rotate (in a direct or retrograde sense) in periods which differ from that of orbital revolution, were investigated. The components constituting the binary are regarded as self-gravitating configurations, consisting of viscous compressible fluid, the viscosity of which varies with the 2.5th power of local temperature (indicated by theoretical investigations of the viscosity of hydrogen plasma). The equilibrium structure of the components was assumed to be polytropic of index n; and numerical computations were carried out for the values of n = 1.5, 2.5, 3.5 and 4.5. The magnitudes of the tidal lag $\pi/2\ \epsilon_i$ for these models and for different values of the ratio of the angular velocities of rotation and revolution are listed in terms of six values of a non-dimensional parameter Z which is proportional to viscosity. (auth)

19701 FABRY-PEROT OBSERVATIONS OF THE ROSETTE NEBULA. Smith, Malcolm G. (Univ. of Manchester, Eng.). Astrophys. Space Sci., 11: 68-73(Jan. 1968).

The results of observations of the Rosette Nebula using the equipment described by Meaburn and Smith (1968) and the reduction procedures outlined in Smith and Walker (1968) are reported. The results and conclusions differ markedly from an earlier report (Flynn, 1965), of detailed radial-velocity observations of this nebula. The peak positions of the Hα-line profiles are now shown to vary greatly. The mean of 37 measurements of different points gives, for the heliocentric velocity of the Rosette nebula, +35 ± 5 km sec^{-1}. The widths of the lines are consistent with a model of randomly directed streaming motions of order 15 to 25 km sec^{-1}. (auth)

19702 PRECESSION AND NUTATION OF DEFORMABLE BODIES. Kopal, Zdenek (Boeing Scientific Research Labs., Seattle). Astrophys. Space Sci., 1: 74-91(Jan. 1968).

The aim of the present paper was to derive from the fundamental equations of hydrodynamics the explicit form of the Eulerian equations which govern the motion about the center of gravity of self-gravitating bodies, consisting of compressible fluid of arbitrary viscosity, in an arbitrary external field of force. If the problem is particularized so that the external field of force represents the attraction of the Sun and the Moon, this motion would represent the luni-solar precession and nutation of a fluid viscous earth; if, on the other hand, the external field of force were governed by the Earth (and the Sun), the motion would define the physical librations of the Moon regarded as a deformable body. The same equations are, moreover, equally applicable to the phenomena of precession and nutation of rotating fluid components in close binary systems, distorted by mutual tidal action; and the present paper contains the first formulation of the effects of viscosity on such phenomena. (auth)

19703 MOTION OF ROTATING SPHEROIDAL BODIES IN GENERAL RELATIVITY. Lanzano, Paolo (North American Aviation, Inc., Downey, Calif.). Astrophys. Space Sci., 1: 92-111(Jan. 1968).

The motion of two rotating spheroidal bodies, constituting the components of a binary system in a weak gravitational field, was considered up to terms of the second order in the small parameter V/c, where V denotes the velocity of the bodies and c is the velocity of light. The following simplifying assumptions, consistent with a problem of astronomical interest, were made: (1) the dimensions of the bodies are small compared with their mutual distance; (2) the bodies consist of matter in the fluid state with internal hydrostatic pressure and their oblateness is due to their own rotation; (3) there exist axial symmetry about the axis of rotation and symmetry with respect to the equatorial plane, the same symmetry properties apply to mass densities and stress tensors. The Fock-Papapetrou method was used to ascertain those terms in the equations of motion which are due to the rotation and to the oblateness of each component. Approximate solution to the Poisson and wave equations were obtained to express the potential and retarded potential at large distances from the bodies generating them. The explicit evaluation of certain integrals necessitated the use of the Laplace-Clairaut theory for the equilibrium configuration of rotating bodies. The final expressions require the knowledge of the mass density as a function of the mean radius of the equipotential surfaces. As an interpretation of the results, the Lagrangian perturbation equations were employed to evaluate the secular motion of the nodal line for the relative orbit of the two components. The results constitute a generalization of Fock's work and furnish the contribution of the mass distribution to the rotation effect of general relativity. (auth)

19704 MODELS OF DENSE STARS. Kopal, Zdenek; Shapley, Martha B. (Univ. of Manchester, Eng. Massachusetts Inst. of Tech., Cambridge). Astrophys. Space Sci., 1: 112-24(Jan. 1968).

The results are presented of a construction of five models of composite stellar configurations, consisting of an energy-generating convective core surrounded by source-free envelope in radiative equilibrium, and of sufficient density for the coefficient of absorption to vary approximately as inverse square of the local temperature. The principal characteristic of such models proved to be their very high degree of central condensation; their central densities being 10^3 to 10^4 times as large as the mean density of the composite configuration. The relevance of such models to the internal structure of subdwarf components of close binary systems with periods less than a day is briefly pointed out. (auth)

19705 CLOSE BINARY SYSTEMS. PART II. Smak, Jozef. Postepy Astron., 16: 3-29(Jan.-Mar. 1968). (In Polish).

A review is given on selected observational results and problems in the field of the close binary systems. (auth)

19706 FLOW OF THE MECHANICAL ENERGY IN THE SUN'S ATMOSPHERE. Stankiewicz, Adolf. Postepy Astron., 16: 31-43 (Jan.-Mar. 1968). (In Polish).

A review of physical processes connected with mechanical energy transport is given. The generation and dissipation of sound and magnetohydrodynamic waves in the solar atmosphere is described and numerical estimations of fluxes transported to the chromosphere and corona are discussed. (auth)

19707 NONRADIAL PROBLEMS IN THE THEORY OF STELLAR STRUCTURE. PART III. Dziembowski, Wojciech. Postepy Astron., 16: 45-55(Jan.-Mar. 1968). (In Polish).

The theory of star rotation is considered, particularly the process of stabilization of angular velocity distribution inside the star and cases of stationary distributions. Flow in binary systems is treated and the nonadiabatic flows in quasi-static approximation are taken into consideration. (auth)

19708 STUDY OF THE PULSATION OF THE ENVELOPE OF HD 37202. Delplace, Anne-Marie (Observatoire de Paris, Meudon, France). Compt. Rend., Ser. A and B, 266: 265-8(Jan. 22, 1968). (In French).

The pseudo-period of 7 years of ζ Tau (HD 37202) is confirmed. There is a close relation between the variation of the profile of Hβ and this period. The velocity of the star, measured from the He I λ 4026 ray, is close to zero. (tr-auth)

19709 METAGALACTIC COSMIC RAYS. Ginzburg, V. L. (Lebedev Physical Inst., Moscow). Astrophys. Space Sci., 1: 125-8(Jan. 1968).

The simple argument is presented to show that the average energy density of cosmic rays in the Metagalaxy must be smaller than in the Galaxy. This conclusion could, in principle, be not valid in the Lemaître cosmological model. The gamma-ray astronomical data now available testify, however, against the possibility of the cosmic-ray storage during the "stop" phase of the Lemaître model. The measurements of the diffuse background gamma-ray intensity with energy exceeding 10 MeV could definitely solve this problem. (auth)

19710 RAPID NEUTRON CAPTURE IN SUPERNOVA EXPLOSIONS. Truran, J. W. (Goddard Space Flight Center, New York); Arnett, W. D.; Tsuruta, S.; Cameron, A. G. W. Astrophys. Space Sci., 1: 129-46(Jan. 1968).

The implications of recent studies of the dynamics of the cores of highly evolved massive stars are considered with regard to the general problems of nucleosynthesis. The typical conditions estimated for these models are shown to be very promising for the process of element synthesis by neutron capture on a fast time scale (the r-process of Burbidge et al., 1957). (auth)

19711 LUNAR-MONTH MODULATION OF LARGE SOLAR-TERRESTRIAL DISTURBANCES. Smerd, S. F. (Commonwealth Scientific and Industrial Research Organization, Sydney). Proc. Astron. Soc. Aust., 1: 11-12(Jan. 1967). (RPP-1070).

Dodson and Hedeman discovered an unexpected effect in the occurrence of solar proton events as revealed by polar cap absorption. When 48 events in Bailey's Catalog of the Principal PCA events, 1952–1963 are distributed with the phase of the moon there is a gap of several days near full moon; also, many more events occur when the moon waxes than when it wanes. They did not find similar, apparent departures from random distribution either with a mean solar rotation period of 27.3 days or for solar flare events. They concluded that "at present time it is not clear whether the 29.5-day effect is related to the Sun or the Moon or is only a statistical accident." A similar analysis was carried out using a more complete list of PCA's and the same effect was apparent. (W.D.M.)

19712 INTERACTION OF THE PLANETS THROUGH THE SOLAR WIND. Bowen, E. G. (Commonwealth Scientific and Industrial Research Organization, Sydney). Proc. Astron. Soc. Aust., 1: 5-6(Jan. 1967). (RPP-1068).

It is usual to describe the motion of the planets around the Sun in terms only of the gravitational forces between them. It is pointed out that another form of interaction between bodies in the solar system is possible through the medium of the solar wind. (W.D.M.)

19713 FORMATION OF SIMULTANEOUS RADIO ASTRONOMICAL IMAGES AND SPECTRA BY ELECTRO-OPTIC METHODS. McLean, D. J. (Commonwealth Scientific and Industrial Research Organization, Sydney). Proc. Astron. Soc. Aust., 1: 33-4(Jan. 1967). (RPP-1066).

Techniques, new to radio astronomy, are described which permit the analysis of electrical signals at radio-frequencies by optical methods. Two applications are described: the first is to a spectrograph which gives the instantaneous power spectrum of a single broad-band electrical signal; the second is to the analysis of the signals from a number of aerials of an array in order to form a simultaneous image of the brightness distribution of the region of the sky under observation. (W.D.M.)

19714 STABILITY OF DENSITY WAVES IN A SELF-GRAVITATING STELLAR SYSTEM WITH UNIFORM ROTATION. Wu, C.-S. (Massachusetts Inst. of Tech., Cambridge. California Inst. of Tech., Pasadena). Phys. Fluids, 11: 545-56 (Mar. 1968).

The collective processes in a self-gravitating system with uniform rotation are studied with particular emphasis on the stability of density waves. In addition to the classical Jeans instability, it is shown that the so-called microinstability can also exist if the distribution is anisotropic and $\beta \simeq 0.54$. The critical wavelength is calculated as a function of β for nearly transversely propagated modes and is also estimated for the case that waves have arbitrary propagation direction and long wavelength. Finally, the stability of density waves associated with a system in the presence of the Kapteyn–Eddington star stream is examined. (auth)

19715 MODELS OF THE TRANSITION REGION BETWEEN CHROMOSPHERE AND CORONA. Tominaga, Susumu (Kyoto Univ.). Mem. Fac. Sci., Kyoto Univ., Ser. Phys., Astrophys., Geophys., Chem., 32: 49-71(Sept. 1967).

In order to obtain a piece of information about N_e and T distributions in the transition region between the chromosphere and corona, observations of uv resonance lines are connected with those of radio emission in cm and dm ranges. Models of the transition region are computed for three possible values of the coronal density assuming hydrostatic equilibrium. The models show such steep temperature and density gradients that the uv lines of intermediate ions are produced in very thin regions. The models are not inconsistent with observations of the uv bound–free emission and visible continuum in the flash spectrum. It may be inferred from the models that interspicular regions consist of coronal matter with $T \sim 10^6$ and $N_e \sim 10^9$. (auth)

19716 VARIATION OF ANGULAR AND ENERGY DISTRIBUTION OF CHARGED PARTICLES IN FLIGHT WHEN CROSSING A MAGNETIC FIELD. Gernet, G. E. (Leningrad Electrotechnical Inst.). Dokl. Akad. Nauk SSSR, 173: 544-5(Mar. 21, 1967). (In Russian).

An attempt is made to determine the influence of bremsstrahlung on the angular and energy distribution of charged particles passing through a magnetic field with finite thickness. The results may be applied to fast electron motion in stellar atmospheres and nebulae with strong magnetic fields. (R.V.J.)

19717 PULSATING RADIO SOURCE AT $\alpha = 19^h19^m$, $\delta = +22^0$. Davies, J. G.; Horton, P. W.; Lyne, A. G.; Rickett, B. J.; Smith, F. G. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London), 217: 910-12(Mar. 9, 1968).

Signals from one of the rapidly pulsating radio sources were recorded on three frequencies using the Mark I radio telescope at the Nuffield Radio Astronomy Laboratories. The size of the source, deduced from the form of the signals, seems consistent with an origin in a white dwarf or neutron star. (auth) (UK)

19718 OPTICAL IDENTIFICATION OF THE FIRST NEUTRON STAR? Ryle, M.; Bailey, Judy A. (Cambridge Univ., Eng.). Nature (London), 217: 907-10(Mar. 9, 1968).

A more precise position for one of the rapidly pulsating radio sources has been found. This has suggested that the source is associated with an eighteenth magnitude blue star. (auth) (UK)

19719 STIMULATED INVERSE COMPTON SCATTERING IN RADIO SOURCES. Goldreich, P.; McCray, R.; Rees, M. J. (California Inst. of Tech., Pasadena). Nature (London), 217: 931-2(Mar. 9, 1968).

It has been stated (Oster, Nature 217: 148(1968)) that energy losses due to the inverse Compton effect can be considerably larger than previously thought when stimulated scattering is taken into account. If this is true it would seriously hamper understanding of compact radio sources. The present authors show that Oster's discussion is erroneous and grossly exaggerates the importance of stimulated inverse Compton scattering. (UK)

19720 OBSERVATIONS OF THE BEAMING OF JUPITER'S RADIO EMISSION AT 620 AND 2650 Mc/sec. Roberts, J. A.; Ekers, R. D. (Radiophysics Lab., Sydney). Icarus, 8: 160-5 (Jan. 1968).

At frequencies above 1000 Mc the radio emission from Jupiter varies by approximately 10% as the planet rotates, but at 408 Mc no variation has been detected. Observations at the intermediate frequency of 620 Mc reported here show variations similar to those found at the higher frequencies. This confirms results at 610 Mc reported by Barber. A new series of observations at 2650 Mc defines the variation with rotation very clearly. The results can be explained by synchrotron beaming in a dipole field with the axis inclined about 15° to the axis of rotation, whereas the tilting of the plane of polarization requires an inclination of 10°. (auth)

19721 FORMATION OF THE PLANETS. Pendred, B. W.; Williams, I. P. (Univ. of Reading, Eng.). Icarus, 8: 129-37 (Jan. 1968).

The possibility of formating a planetary system, starting from a diffuse rotating cloud of gas and dust, as a result of accretion by

a proto-Sun is investigated. It is found that a ring of relatively high density is formed in the equatorial plane of the proto-Sun gas cloud system. This ring moves outwards from the Sun with the passage of time. An increase in the temperature of the gas in the ring comes about as a direct consequence of the formation of the ring. The amount of the increase in temperature however is found to diminish as the ring moves outwards. Therefore, while only nonvolatile material can start to condense in the ring while it is near the Sun, volatile material also starts to condense further out. When numerical values for the parameters involved are introduced, it is seen that a planetary system generally resembling the present solar system is formed in a period of time that appears to be reasonable. (auth)

19722 ELECTRODYNAMIC EFFECTS OF JUPITER'S SATELLITE Io. Piddington, J. H.; Drake, J. F. (Univ. of Iowa, Iowa City). Nature (London), 217: 935-7(Mar. 9, 1968).

It is stated that Io exerts a remarkable control over Jovian decametric radio emission, and also has a very high and possibly varying albedo. The Jovian magnetosphere rotates with the planet, causing Io to move westwards through the magnetosphere at a speed of ~56 km/sec. This motion may cause an electromagnetic disturbance which contributes to the radio emission. The possible form of the electromagnetic disturbance has been discussed by a number of authors, and the possible importance of the low-velocity hydromagnetic mode has been mentioned. Long immersion of the satellite in the steady magnetospheric field must ensure its magnetization. If Io is magnetized and is conducting, then its relative motion through the magnetosphere will have drastic results. The resulting effects are discussed, particularly in regard to Jovian decametric radio emission, radiation belts, etc.; also the unusual optical properties of Io. (UK)

19723 LIMIT ON THE CONTINUOUS SOLAR FLUX OF THE 2.22-MeV NEUTRON–PROTON CAPTURE GAMMA RAY. Chupp, E. L.; Lavakare, P. J.; Sarkady, A. A. (Univ. of New Hampshire, Durham). Phys. Rev., 166: 1299-1301(Feb. 25, 1968).

An upper limit on the continuous emission of 2.22-MeV photons (neutron-proton capture γ rays) from the sun has been determined from day and night balloon flights in May and June of 1967, from Palestine, Texas at an atmospheric depth of ~3.8 g/cm^2. The experimental apparatus consisted of a 3 in. × 3 in. CsI(Tl) γ-ray spectrometer and airborne telemetry to transmit the pulse-height distribution to the receiving station, where it was recorded on magnetic tape for later analysis by a laboratory multichannel analyzer. On-board calibration sources giving lines below 2.22 MeV were always present in the spectrum and allowed a continual check on the stability of the apparatus. Comparison of the day and night average counting rates as well as the daytime absence of any line leads to a null result for any statistically significant solar flux of 2.22-MeV photons. Our resulting upper-limit flux is comparable with the value of 5×10^{-3} photon cm^{-2} sec^{-1} determined from the Ranger-3 experiment in January 1962 at a considerably different phase of the solar cycle. (auth)

19724 ISOTOPIC ANALYSIS OF LITHIUM IN THE HOLBROOK METEORITE AND IN TERRESTRIAL SAMPLES WITH A SPUTTERING ION SOURCE MASS SPECTROMETER. Gradsztajn, Eli; Salome, Michel; Yaniv, Akiva; Bernas, Rene (Centre National de la Recherche Scientifique, Orsay, France). Earth Planet. Sci. Lett., 3: 387-93(Feb. 1968).

The isotopic composition and the distribution of lithium have been studied in the Holbrook meteorite, in granite, and in hornblende, using a sputtering-ion-source mass spectrometer. In granite and hornblende, the isotopic ratios obtained for all the points of the surface investigated remain 12.0 within a ±2% uncertainty (uncorrected for mass discrimination). With exactly the same technique, the ratios obtained in Holbrook show fluctuations of about ±10% around an average of 12.0. (auth)

19725 ARGON, KRYPTON, AND XENON IN ANGRA DOS REIS, NUEVO LAREDO, AND NORTON COUNTY ACHONDRITES: THE CASE FOR TWO TYPES OF FISSION XENON IN ACHONDRITES. Munk, Miner N. (Univ. of California, Berkeley). Earth Planet. Sci. Lett., 3: 457-65(Feb. 1968).

Argon, krypton, and xenon analyses of the uranium-rich achondrites Angra dos Reis and Nuevo Laredo are reported. Results for the Norton County aubrite show good agreement with previously reported analyses from other laboratories. Cosmic-ray exposure ages of 68 and 16 m.y. for Angra dos Reis and Nuevo Laredo were obtained by comparing ^{38}Ar/Ca ratios with Stannern whose cosmic-ray exposure age has previously been determined by the ^{81}Kr–^{79}Kr method. Contrary to the earlier analysis of Nuevo Laredo by Reynolds and Lipson, both Angra dos Reis and Nuevo Laredo showed pronounced fission-xenon anomalies. Failure of the fission-xenon composition obtained by an Angra dos Reis–Stannern subtraction to match that of Pasamonte suggests there is more than one type of fission xenon in the calcium-rich achondrites and at the same time invalidates the subtraction method. After spallation-component and trapped-component corrections, the following xenon composition was obtained for Angra dos Reis (Nuevo Laredo): ^{131}Xe, ^{132}Xe, ^{134}Xe, and ^{136}Xe/0.81 (0.54), ≡1.00 (≡1.00), 0.96 (1.13), and 1.06 (1.27). In this case inclusion of errors makes the ratios slightly overlap, but the difference again suggests more than one type of fission xenon. If other previously reported calcium-rich achondrites are treated the same way, a spread in the composition of the fission-xenon components with the ^{134}Xe/^{132}Xe ratios varying in an approximately linear way with the ^{136}Xe/^{132}Xe ratios is found. This linear spread suggests that there are two types of fission xenon in the calcium-rich achondrites. Either xenon from spontaneous fission of ^{238}U or the carbonaceous-chondrite-type fission xenon recently reported by Pepin would provide the end member with high ^{134}Xe/^{132}Xe and ^{136}Xe/^{132}Xe ratios, but the data indicate an additional type of fission xenon with low ^{134}Xe/^{132}Xe and ^{136}Xe/^{132}Xe ratios. Spontaneous fission of ^{238}U, which of all uranium fissions is expected to make the largest contribution to xenon, is insufficient by factors of 34 and 18 in providing for the amount of fission ^{136}Xe in Angra dos Reis and Nuevo Laredo. Using the previously reported krypton and xenon data for Stannern, an additional argument is made against uranium fission in Angra dos Reis. The purity of the spallation-krypton spectrum in Stannern allows an upper limit to be placed on the ^{82}Kr from fission in Angra dos Reis, which is 6% of the ^{136}Xe due to fission and a factor of two less than expected for spontaneous fission of ^{238}U. This argument also more strongly rules out neutron fission of ^{235}U as a major source of fission xenon in Stannern. (auth)

19726 THE SPECTRUM OF Z CAM DURING A LIGHT STAGE. Lortet-Zuckermann, Marie-Claire (Institut d'Astrophysique, Paris). Compt. Rend., Ser. A and B, 265: 826-9 (Oct. 9, 1967). (In French).

The spectrum of Z Cam taken during a light stage resembles that of stars of the U Gem type during the decline following an explosion. A remarkable trait is the appearance of the H_2 absorption lines: they are large, approximately symmetric, with very extended wings and a central emission. (tr-auth)

19727 HIGH-ENERGY NUCLEAR REACTIONS IN ASTROPHYSICS. A COLLECTION OF ARTICLES. Shen, B. S. P. (ed.). New York, W. A. Benjamin, Inc., 1967. 289p. $9.75.

This collection of review articles is based mainly on papers given at the 1967 Symposium on High Energy Nuclear Reactions in Astrophysics held at the University of Pennsylvania. The articles discuss spallation reactions and their occurrence in various natural settings. This volume will be of interest to physicists, nuclear chemists, astronomers, geophysicists, and space scientists, and is suitable as a supplementary text for courses in nuclear chemistry, cosmic rays, astrophysics, and space physics. Separate abstracts were prepared for the ten chapters. (auth)

For abstracts of individual chapters see: 19728–19733 and 19807–19810.

19728 HIGH-ENERGY NUCLEAR REACTIONS. Miller, J. M. (Columbia Univ., New York). pp 19-36 of High-Energy Nuclear Reactions in Astrophysics. Shen, B. S. P. (ed.). New York, W. A. Benjamin, Inc., 1967.

This brief review of high-energy nuclear reactions includes a survey of the observed phenomena, a sketch of the theoretical framework within which these phenomena are interpreted, and a criticism of this framework both from a fundamental point of view and from a comparison between theoretical and calculated results. (auth)

19729 ORIGIN OF THE RARE LIGHT NUCLIDES. Mitler, Henri E. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). pp 59-80 of High-Energy Nuclear Reactions in Astrophysics. Shen, B. S. P. (ed.). New York, W. A. Benjamin, Inc., 1967.

A critical review is given of the major theories of light-element (deuterium, lithium, beryllium, boron) production, principally in the solar system. A new model that meets most of the difficulties is proposed. ^{7}Li and ^{2}H are assumed to have been created in approximately their observed abundances in a "big bang." The Sun then supplied the ^{6}Li, Be, and B isotopes in the required amounts through spallation production in its T-Tauri phase. The meteoritic, terrestrial, and solar abundances are then given consistently. There is no need to invoke lithium or boron destruction by neutron or proton reactions, except for a residual lithium on the Sun. This, on the other hand, suggests that the bottom of the convection zone is at a much higher temperature than is currently believed. The solar boron abundance is predicted to be ~240 (with Si = 10^6). Some new chains that hurdle the A = 5, 8 barrier are suggested

and, in particular, the $Be^{9}(\alpha,n)C^{12}$ reaction to substitute for the 3 α reaction. (auth)

19730 STELLAR OBSERVATIONS OF THE RARE LIGHT ELEMENTS. Danziger, I. J. (Harvard Coll. Observatory, Cambridge, Mass.). pp 81-98 of High-Energy Nuclear Reactions in Astrophysics. Shen, B. S. P. (ed.). New York, W. A. Benjamin, Inc., 1967.

This review summarizes the recent observational data on light elements in stars and the interstellar medium. Some of the relevant nuclear physics is discussed briefly, followed by the observations for the Sun, the youngest stellar object, with a progression to more highly evolved ones. Only the following isotopes are discussed: D, ^{3}He, ^{6}Li, ^{7}Li, and ^{9}Be. (W.D.M.)

19731 HIGH-ENERGY NUCLEAR REACTIONS IN SOLAR FLARES. Lingenfelter, R. E.; Ramaty, R. (Univ. of California, Los Angeles). pp 99-158 of High-Energy Nuclear Reactions in Astrophysics. Shen, B. S. P. (ed.). New York, W. A. Benjamin, Inc., 1967.

Previous calculations and measurements are reviewed, and an attempt is made to present a unified treatment of the problem by exploring the expected interrelations between the various secondary fluxes produced in high-energy reactions in solar flares. The nuclear interactions that one might expect to occur in the solar atmosphere, based on the elemental abundances in the solar atmosphere, on high-energy particle fluxes, and on the cross sections for interaction between these nuclei, are considered along with the secondary particles and radiation fluxes produced in flares, both during the acceleration of the flare particles and during the slowing down of those particles which possibly do not escape from the flare region. (W.D.M.)

19732 PRODUCTION OF Li, Be, AND B ISOTOPES IN C, N, AND O. Gradsztajn, Elie (Univ. de Paris, Orsay, France). pp 247-54 of High-Energy Nuclear Reactions in Astrophysics. Shen, B. S. P. (ed.). New York, W. A. Benjamin, Inc., 1967.

For all theories stating that the Li, Be, and B isotopes present in the solar system have been formed through the spallation of C, N, and O, a crucial test is to compare the formation ratios $^{7}Li/^{6}Li$ and $^{11}B/^{10}B$ with the observed ratios in the Earth and meteorites. If the spallation ratios do not have the same values as the observed ones, then a second process following the production must be invoked to explain the alteration of the spallation ratios. This problem gave rise to various models using estimated, measured, or calculated spallation cross sections. In this article, some new experimental and calculated production rates are presented. (W.D.M.)

19733 SURVEY OF EXPERIMENTAL CROSS SECTIONS FOR PROTON-INDUCED SPALLATION REACTIONS IN ^{4}He, ^{12}C, ^{14}N, AND ^{16}O. Audouze, Jean; Epherre, Marcelle; Reeves, Hubert (Univ. de Paris, Orsay, France). pp 255-71 of High-Energy Nuclear Reactions in Astrophysics. Shen, B. S. P. (ed.). New York, W. A. Benjamin, Inc., 1967.

The experimental results on the formation of spallation products by proton bombardment of ^{4}He, ^{12}C, ^{14}N, and ^{16}O, published before August 1967, are reported. This survey was made in the frame of a study of various problems of nucleosynthesis involving in particular the formation of Li, Be, and B in the solar system. (W.D.M.)

19734 ELECTROMAGNETIC SENSING OF THE EARTH FROM SATELLITES. Proceedings of the Symposium held at Coral Gables, Florida, November 22-24, 1965. Zirkind, Ralph (ed.). Brooklyn, Polytechnic Press of the Polytechnic Institute of Brooklyn, 1967. 384p. (CONF-651159).

This symposium was held with the objective that the scope be broad both in spectral bandwidth and techniques. Hence, the papers selected covered the entire electromagnetic spectrum and current and advanced techniques. The latter included both active and passive methods. (W.D.M.)

Atomic and Molecular Physics

Refer also to abstracts 19096, 19102, 20041, 20050, 20096, 20201, and 20482.

19735 (INP-555/PH, pp 99-105) 0(4) SYMMETRY AND HYDROGEN ATOM. Sredniawa, Bronislaw (Jagellonian Univ., Krakow (Poland). Inst. of Physics).

The 0(4) group is used in calculations for the hydrogen atom. The energy levels are obtained with the correct degeneracy. Proofs are given which are not purely quantum mechanical but also contain classical arguments. (J.F.P.)

19736 (LA-3816) X-RAY SCATTERING FACTORS COMPUTED FROM NUMERICAL HARTREE-FOCK WAVE FUNCTIONS. Cromer, Don T.; Mann, Joseph B. (Los Alamos Scientific Lab., N. Mex.). Dec. 20, 1967. Contract W-7405-eng-36. 69p. Dep. CFSTI.

X-ray-scattering factors for neutral atoms from He to Lw and for most of the chemically significant ions through Lu^{3+} have been computed from numerical Hartree-Fock wave functions. The results are given in numerical tables and in the form of coefficients for an analytic function. (auth)

19737 (NRL-6648) ATOMIC EMISSION LINES BELOW 2000 ANGSTROMS HYDROGEN THROUGH ARGON. Kelly, Raymond L. (Naval Postgraduate School, Monterey, Calif. Naval Research Lab., Washington, D. C.). Feb. 1968. 356p. GPO $3.25.

A tabulation of observed spectral lines below 2000 Å has been prepared from the published literature up to January 1967. It is intended principally as an aid to the astrophysicist and to the plasma spectroscopist who deals with the spectra of highly stripped atoms. This report includes the first 18 elements, hydrogen through argon. The tabulation is divided into two main sections: the emission lines by spectrum, and a finding list. The entries give the element and spectrum, vacuum wavelength, intensity, and classification. A reference list is included. (auth)

19738 (ORO-3027-12) THE EXCITATION OF BARIUM IONS BY ELECTRON IMPACT. Summary Report, June 1, 1965-January 31, 1968. Bacon, F. M.; Hooper, J. W. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Feb. 1, 1968. Contract AT(40-1)-3027. 108p. Dep. CFSTI.

A crossed-beam technique has been developed for measuring the emission cross section for the excitation of electric dipole transitions in ions by electron impact. The method involves crossing modulated ion and electron beams in a well-defined collision volume. A portion of the photon flux radiated from the excited ions is detected at an angle of 90° to the plane of the two beams by direct observation of the collision volume with a photomultiplier tube. The selection of a single emission line is accomplished with an interference filter. The total flux of radiation from the collision volume for a particular transition can be determined with a knowledge of the photon detection probability of the apparatus. The possibility of an anisotropic angular distribution of radiation from the collision volume is evaluated by measuring the polarization fraction. The emission cross section can be determined from the ion and electron beam currents, current-density distributions and energies, and the total radiation flux. This technique has been used to measure the relative emission cross sections for excitation of the resonance transitions in Ba^{+} ions by electron impact. The resonance transitions, between the excited $6^{2}P^{0}_{\frac{1}{2}}$ and $6^{2}P^{0}_{\frac{3}{2}}$ levels and the $6^{2}S_{\frac{1}{2}}$ ground state, produce photons with wavelengths of 4934 and 4554 Å. The thresholds for exciting the $6^{2}P^{0}_{\frac{1}{2}}$ and $6^{2}P^{0}_{\frac{3}{2}}$ levels are 2.5 and 2.7 eV, respectively. Over the energy range of the experiment, from 8 to 98 eV, the relative cross sections differ by approximately a factor of two, the ratio of the statistical weights of the 6P levels. The relative data also exhibit the high energy dependence predicted by the Bethe-Born approximation. From a best estimate of the photon detection probability of the apparatus, estimated absolute cross sections are obtained, which agree remarkably well in magnitude and shape with the theoretical predictions. Checks on the data were performed to evaluate the possible effects of such parameters as the beam intensities, beam modulation frequency, ion beam composition, ion beam energy, electron beam energy distribution, beam profiles, and signal-to-noise ratio. (auth)

19739 (NP-tr-1613) ESTIMATING LONG-RANGE INTERACTIONS BY A MODIFIED METHOD OF STRONG COUPLING. Damburg, R.; Karule, E. Translated by J. E. Baker for Atomic Energy Research Establishment, Harwell, Eng., from a report. 13p. Dep. CFSTI. UK. JCL $1.60 fs, $0.80 mf.

A modified method of strong coupling is presented which makes it possible to make full allowance for dipole and quadrupole polarization by solving a limited number of integral-differential equations. The extremal properties of the phase are retained. (M.H.R.)

19740 SPIN POLARIZATION OF ELECTRONS EJECTED IN COLLISIONAL IONIZATION OF FAST, POLARIZED METASTABLE DEUTERIUM ATOMS. Donnally, Bailey; Raith, Wilhelm; Becker, Roger (Yale Univ., New Haven). Contract AT(30-1)-2726. Phys. Rev. Lett., 20: 575-8(Mar. 18, 1968). (YALE-2726-516).

Mott scattering was used to determine the polarization of the electrons ejected in collisions between fast, polarized metastable deuterium atoms and the atoms or molecules of a diamagnetic target gas. (M.O.W.)

19741 THICK TARGET ENERGY LOSS DISTRIBUTIONS OF ELECTRONS. Van Camp, K. J.; Vanhuyse, V. J. (Rijksuniversiteit, Ghent). Z. Phys., 211: 152-64(Mar. 19, 1968).

Energy loss distributions of electrons with initial kinetic energies of 1.52, 2.65, and 3.66 MeV were measured after penetration through Al, Cu, Ag, and Au targets with thicknesses ranging from 0.2 to 0.7 g/cm^2. The most probable energy loss W and the width B of the distributions were compared with theoretical results. Fair agreement is obtained for W if the pathlength distribution due to multiple scattering of the electrons in the target is taken into account. This pathlength distribution was obtained by a slight modification of Yang's formula. For B a discrepancy remained especially for the high Z materials which is probably due to an underestimation of the bremsstrahlung broadening in the theory of Blunck and Westphal for energy loss distributions. (auth)

19742 HYPERFINE STRUCTURE OF SOME INFRARED LASER LINES OF ^{129}Xe. Liberman, Sylvain (CNRS, Orsay, France). Compt. Rend., Ser. A and B, 266: 236-9(Jan. 22, 1968). (In French).

The results of the study of the hyperfine structure of infrared laser lines of ^{129}Xe made possible the determination of the hyperfine structure constants of several levels of the 5 p^5 5 d configuration. (tr-auth)

19743 QUANTUM OSCILLATIONS IN THE SHAPE OF PRESSURE-BROADENED ATOMIC LINES. Mies, Frederick H. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 48: 482-94(Jan. 1, 1968).

Oscillatory or bandlike structure is predicted to occur in the wings of pressure-broadened atomic lines when the interaction potential between the emitting atom M* and the perturbing atom A is deeply attractive compared to kT and the interaction in the final state is repulsive. The oscillations in intensity arise from quantum effects and are associated with the nodal structure of the continuum wave function that describes the dissociated state of the diatomic molecule (A + M*). The number of maxima in the line shape is a measure of the number of bound states that can be supported in the potential while the amplitude and resolution of the oscillations depend on the long-range behavior of the potential. The bandlike structure, which may extend over thousands of cm^{-1} on the long-wavelength side of the atomic emission line, is resolvable as long as kT < ~$\frac{1}{10}$ the vibrational quantum $\hbar\omega_e$ of the AM* molecule. This is a generalization of similar bandlike structure, which has been calculated and observed to occur in the collision-induced radiation of helium metastable atoms and which is merely a special case of pressure broadening involving forbidden lines. Specific calculations are presented for the broadening of the hydrogen Lyman-α line by H(1s), and the visible absorption spectra of H(1s) in the presence of free protons. The quantum theory of line shape employed here was first developed by Jablonski but then neglected because of difficulties involved in evaluating essentially the band strength for continuum–continuum transitions of diatomic molecules. Jablonski introduced the WKB and other approximations into his theory, which reduced it to the classical statistical theory. These approximations are compared to exact quantum-mechanical calculations. The WKB approximation is shown to be quite valid in the special case of attractive–repulsive transitions, but Jablonski then improperly averaged over those very quantum oscillations of interest here. This structure offers a unique and extremely sensitive method of studying interaction potentials involving excited states of atoms. (auth)

19744 MOLECULAR BEAMS. Hushfar, F.; Stair, A. T. Jr. Res./Develop., 19: 24-8(Feb. 1968).

Molecular beams at 1 to 10 eV show promise of becoming fundamental probes in physics and chemistry, especially for chemical reactions and bonding of molecules. Beam production at these energies, their detection, and their applications (gas–gas and gas–surface interactions) are briefly reviewed here. (L.M.T.)

19745 LOW-ENERGY ION-MOLECULE REACTIONS. Fink, Richard D.; Broad, John T. (Amherst Coll., Mass.). J. Chem. Phys., 48: 1400-2(Feb. 1, 1968).

The reactions of molecular hydrogen and deuterium with ions of N_2^+ were studied by introducing a velocity-selected beam of N_2^+ ions into a chamber containing H_2 or D_2 gas. The laboratory kinetic energy of the ion beam was varied from 6 to 30 eV, and the velocity spectra of the product ions from the reactions $N_2^+ + H_2 \rightarrow N_2H^+ + H$ and $N_2^+ + D_2 \rightarrow N_2D^+ + D$ were measured. The results give no indication of the formation of a long-lived intermediate complex, but do, in general, appear to fit the ion–induced-dipole modified stripping theory developed by Wolfgang and coworkers. (A.G.W.)

19746 CORRELATION OF TRIPLET POSITRONIUM ANNIHILATION PARAMETERS WITH STRUCTURAL AND ELECTRONIC PROPERTIES OF ORGANIC LIQUIDS. Gray, Peter P.; Cook, Charles F.; Sturm, Gene P. Jr. (Phillips Petroleum Co., Bartlesville, Okla.). J. Chem. Phys., 48: 1145-57(Feb. 1, 1968).

The parameters of triplet positronium annihilation in 1963 organic liquids have been measured. The annihilation quenching cross section, $\langle\sigma\nu\rangle_{Av} = (1/\tau_2)(M/\rho)$, is a linear function of the length of the molecule in homologous series of compounds. Partial quenching cross sections, calculated for 27 structural functional groups, are used to calculate annihilation cross sections. The importance of steric effects in the annihilation mechanism is demonstrated in the study of several isomeric systems. Triplet positronium intensities depend upon specific atoms of groups in the molecule, rather than any property of the molecule as a whole. A correlation is also shown between annihilation quenching cross sections and electron polarizabilities as measured from indices of refraction. Several systems that quenched the triplet positronium were examined, e.g., free radicals, quinones, and paramagnetic species. (auth)

19747 DIPOLE HYPERPOLARIZABILITIES OF S-STATE ATOMS AND IONS IN THE FIRST TWO ROWS. Drake, G. W. F.; Cohen, M. (York Univ., Toronto). J. Chem. Phys., 48: 1168-77 (Feb. 1, 1968).

The Z expansion technique for calculating atomic properties has been extended to the calculation of dipole hyperpolarizabilities. The leading two terms are of order Z^{-10} and Z^{-11} in the closed-shell case and of order Z^{-7} and Z^{-8} in the open-shell case. The corresponding coefficients have been calculated exactly, and also within the uncoupled Hartree–Fock approximation. Numerical results have been obtained for the ground states of the helium, lithium, and beryllium isoelectronic sequences, and for the metastable ^{1}S and ^{3}S states of the helium sequence. Our Hartree–Fock values for the ground states of the helium sequence are in good agreement with those of Langhoff, Lyons, and Hurst. However, the value derived from the leading two terms of the exact Z expansion for neutral helium is about 40% lower, and even for N^{5+}, the discrepancy is still 10%. For the other sequences, the discrepancies are much larger, extending even to the signs of the hyperpolarizabilities of the lithium and beryllium sequences. The polarizabilities of the above sequences are also included for comparison with other data to indicate the rate of convergence of the asymptotic Z expansions. (auth)

19748 NONEQUILIBRIUM EFFECTS IN FREE-RADICAL RECOMBINATION AND ION–MOLECULE REACTION KINETICS. Pyun, Chong Wha (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys., 48: 1306-11(Feb. 1, 1968).

Distortion of the molecular velocity distribution functions from the Maxwellian form and the resulting deviation of the reaction-rate coefficients from the values calculated with the equilibrium assumption of conventional chemical kinetics are considered for two types of reactions in dilute, isothermal, spatially uniform gas mixtures: free-radical recombination reactions and ion–molecule reactions, both proceeding without an activation energy. The reactive collision cross sections used are those derived from the attractive potentials of the reacting pairs, which are inversely proportional to the sixth and the fourth powers of interparticle distances, respectively. The treatment is based on generalized Boltzmann equations that take into account the effects of reactive collisions, as well as elastic collisions, on the change of the velocity distributions with time. For free-radical recombination reactions, a first-order perturbation approximation analogous to that of Chapman and Enskog is used to derive the composition dependence of nonequilibrium effects. This differs from Mahan's earlier calculation; and, contrary to Mahan's result, the present calculation shows that the deviation of the rate coefficient from the equilibrium value remains small for any mole fraction of free radicals and typical values for various molecular parameters. The possible origin of the difference between the two calculations is analyzed. For the ion–molecule reactions, it is first shown that there is no distortion of the Maxwellian distribution by first-order perturbation theory irrespective of the choice of the series expansion. Next it is proved, without using a perturbation scheme, that nonequilibrium effects in the reaction rates vanish exactly for the ion–molecular reactions. The last conclusion is reached without an explicit assumption about the form of the velocity distribution, just as in the case of the transport properties of Maxwellian molecules that interact according to an inverse fourth-power repulsion potential. The reason for small or vanishing nonequilibrium effects in these reactions without activation energy is discussed. (auth)

19749 WAVEFUNCTIONS AND CORRELATION ENERGIES FOR TWO-, THREE-, AND FOUR-ELECTRON ATOMS. Goddard III, William A. (California Inst. of Tech., Pasadena). J. Chem. Phys., 48: 1008-17(Feb. 1, 1968).

A recently developed method (the GF method), which is equiva-

lent to optimizing the orbitals of a Slater determinant after spin projection, has been applied to H^-, He, Li^+, Be^{2+}, Li, Be^+, B^{2+}, Li^-, Be, B^+, and C^{2+}. These wave functions, which can be given an independent particle interpretation, yield better energies than those of the Hartree–Fock method. For example, H^- and Li^- are correctly predicted to be stable in contradistinction with the Hartree–Fock results. The new correlation energies are tabulated and compared to the Hartree–Fock values. In the case of the two-electron systems the new wave functions are nearly at the radial limit, accounting for 93% to 97% of the radial correlation error present in the Hartree–Fock description. (auth)

19750 SPIN–OTHER-ORBIT INTERACTION IN MANY-ELECTRON ATOMS. Malli, Gulzari (Simon Fraser Univ., British Columbia, Can.). J. Chem. Phys., 48: 1088-91(Feb. 1, 1968).

Spin–other-orbit interactions have been calculated for atoms with p^n and d^n configurations up to radon (Z = 86) using the radial integrals evaluated from numerical Hartree–Fock wave functions. It is found that the absolute value of the spin–other-orbit interaction increases for the atomic configuration $(nl)^N$ as the principle quantum number n increases; it also increases with N in a given shell. (auth)

19751 SPIN–SPIN INTERACTION IN MANY-ELECTRON ATOMS. Malli, Gulzari (Simon Fraser Univ., British Columbia, Can.). J. Chem. Phys., 48: 1092-4(Feb. 1, 1968).

Spin–spin interaction has been evaluated for all the atoms with p^n and d^n configurations using the radial functions calculated from numerical Hartree–Fock wave functions. The magnitude of the interaction is much smaller than the orbit–orbit and spin–other-orbit interaction and may in most practical cases be neglected. (auth)

19752 CRYSTAL ORIENTATION DEPENDENCE OF X-RAY PRODUCTION IN BULK SPECIMENS. Bramman, J. I.; Yates, G. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Phil. Mag., 17: 195-8(Jan. 1968).

The intensity of x rays generated in an attack-polished bulk specimen under given electron-bombardment conditions was shown to depend on the crystal orientation. It was found that the intensity could be changed by about 1.5% by changing the angle of incidence of the electron beam. (auth)(UK)

19753 SPUTTERING OF METALS WITH LOW-ENERGY INERT GAS IONS: POSSIBLE INFLUENCE OF TRAPPED GAS. Sinha, M. K. (North Dakota State Univ., Fargo). J. Appl. Phys., 39: 2150-2(Mar. 1968).

It is shown that at low energies the trapped gas atoms in a metal seem to have strong influence on sputtering yield and the cross-over of yield curves is, perhaps, mainly the result of the trapped gas. Data from Ne, Ar, Kr, and Xe on W are used. (M.O.W.)

19754 THERMALIZATION BY ELASTIC COLLISIONS: POSITRONIUM IN A RARE GAS MODERATOR. Sauder, William C. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 72A: 91-3(Jan.-Feb. 1968).

The energy decay of particles moving through a moderating medium is discussed for the case in which only elastic collisions occur between these incoming particles and the moderator atoms; the random thermal motion of the moderator atoms is taken into account. It is shown that if the cross section is independent of particle velocity the equation for the energy decay emerges in a rather simple form involving the hyperbolic cotangent. Finally, the theoretical development is applied to estimating the thermalization time of positronium in rare gas moderators, and is shown to agree with the limited experimental results presently available. (auth)

19755 SINGLE-PARTICLE GREEN'S FUNCTION FOR A ONE-DIMENSIONAL MANY-FERMION SYSTEM. Theumann, Alba (Yeshiva Univ., New York). J. Math. Phys. (N. Y.), 8: 2460-7(Dec. 1967).

The single-particle Green's function is calculated for a system of N-interacting fermions in one dimension. The problem is exactly soluble in the case of a δ-function potential. The case of a small modification to a δ-function potential is considered and the Green's function is computed up to first order in a perturbation expansion. In both cases it is found that the Green's function has a branch cut in the complex energy plane but it has no single-particle poles. (auth)

19756 KINETIC THEORY OF PLASMAS AND THE RADIATION–MATTER INTERACTION. I. ACTION OF RADIATION ON THE ELECTRON DISTRIBUTION FUNCTION DURING COMPTON SCATTERING. Peyraud, J. (Faculte des Sciences, Orsay, France). J. Phys. (Paris), 29: 88-96(Jan. 1968). (In French).

The action of the radiation on the electron distribution function by means of Compton electron–photon collisions can be described with the aid of a Boltzmann operator. This operator is modified by the induced emission terms. This operator is expanded following the perturbation caused to the electron motion during a Compton collision. The equations of evolution of the electron distribution function are deduced. A definition of the kinetic temperature of non-equilibrium radiation is introduced and the quantity of motion transfer, and the energy transfer between electrons and photons are determined. (auth)

19757 RESONANCES IN ATOMIC COLLISIONS. II. RESONANCE STRUCTURES AND PERTURBATIONS IN ELASTIC ION–ATOM COLLISIONS. Allab, D.; Barat, M.; Baudon, J. (Faculte des Sciences, Orsay, France). J. Phys. (Paris), 29: 111-28 (Jan. 1968). (In French).

The resonances in ion impact elastic differential cross section are reviewed. The theory is developed from the perturbed stationary state approximation. It gives an approximate expression of the charge transfer probability as a function of the scattering angle and explains the oscillations in the elastic differential cross section. Furthermore, the "Rainbow Effect" is developed. In the last theoretical part, other perturbations in cross section, caused by indiscernibility or by coupling of states are studied. Devices used by several workers to measure elastic differential cross-sections or charge-transfer probabilities are described and their results are reviewed. (auth)

19758 HELIUM 3^3 D FINE STRUCTURE. Kaul, R. D. (Lewis Research Center, Cleveland). J. Opt. Soc. Amer., 58: 429(Mar. 1968).

The $3^3D_1 - 3^3D_2$ level separation in helium has been obtained using the method of ion-bombardment level-crossing spectroscopy (J. Opt. Soc. Amer., 57: 1156(1967)). The value obtained for the (1,0) × (2,2) crossing position was 352.26 ± 0.23 G. The $3^3D_2 - 3^3D_3$ level separation had been previously determined by electron-bombardment level-crossing spectroscopy. Combining these two results and the fine-structure equations gives a final result for the $3^3D_1 - 3^3D_2$ level separation of 1327.2 ± 1.1 MHz. The results for the 3^3D fine structure by level-crossing spectroscopy are summarized along with other optical spectroscopy and theoretical results. The lifetime of the 3^3D state of helium as determined by the width of the observed crossing is $(1.32 \pm 0.07) \cdot 10^{-9}$ sec. (TSS)

19759 ATOMIC-ABSORPTION CROSS SECTIONS OF Na, 500 TO 600 A. Hudson, Robert D.; Carter, Virginia L. (Aerospace Corp., Los Angeles). J. Opt. Soc. Amer., 58: 430-1(Mar. 1968).

The authors previously published values of the atomic-absorption cross sections for neutral sodium vapor from its series limit at 2412 to 600 Å. Because of an apparent discrepancy between those measured values and theoretical predictions in the short-wavelength region, cross sections were remeasured in this region and extended down to 500 Å. Best estimates of the cross sections and their errors between 500 and 700 Å, as obtained from a new curve are presented. Results indicate that the cross section reaches a maximum at 600 Å and then slowly decreases with increasing energy to the limit of the measurement. (TSS)

19760 SOLUTION OF ANISOTROPIC SCATTERING TRANSPORT EQUATION. Tamme, E.; Syrmus, I. (Tartu State Univ., USSR). Izv. Akad. Nauk Est. SSR, Fiz. Mat., 16: 412-18(1967). (In Russian).

The transport equation with boundary conditions is examined. To obtain an approximate solution, a system of ordinary differential equations with boundary conditions is formed. The integrals are replaced by sums obtained from quadrature formulas; the numerical solution of the system of differential equations leads to a system of algebraic equations. An application of the principle of maximum will give the estimation of error. The system of algebraic equations is solved by an iteration process, the convergence is established, and the convergence rate determined. (auth)

19761 SPECTRA OF IONS IN THE FLUORINE I ISOELECTRONIC SEQUENCE FROM Sc XIII TO CU XXI. Cohen, Leonard; Feldman, U.; Kastner, S. O. (Goddard Space Flight Center, Greenbelt, Md.). J. Opt. Soc. Amer., 58: 331-4(Mar. 1968).

In a study of the spectra of ions Sc XIII to Cu XXI in the fluorine isoelectronic sequence, lines of the $2p^5 - 2p^43s$ and $2p^5 - 2p^43d$ arrays have been observed and classified, as well as some lines of the $2s2p^6 - 2s2p^53s$ array. Assignments were made on the basis of extrapolations and an intermediate-coupling calculation. The results are compared with those available in the literature. (auth)

19762 RESONANT CHARGE EXCHANGE IN H^- + H COLLISIONS. Yanev, R. K. Vestn. Leningrad. Univ., Ser. Fiz. Khim., No. 22, 61-3(Nov. 1967). (In Russian).

The reaction $H^- + H \rightarrow H + H^-$ is considered by the delta function model in the approximation of perturbed stationary states and in the impact-parameter method. The results are compared with experimental data. It is shown that the delta model is in satisfactory agreement with experiment both in low- and high-energy regions, while the Gurnee–Magee method is not applicable in calculations of the resonant charge exchange of negative ions. (auth)

19763 PARAMETRIC REPRESENTATIONS OF GAS–SURFACE INTERACTION DATA AND THE PROBLEM OF SLIP-FLOW BOUNDARY CONDITIONS WITH ARBITRARY ACCOMMODATION COEFFICIENTS. Shen, S. F. (Cornell Univ., Ithaca, N. Y.). Entropie, No. 18, 138-45(Nov.-Dec. 1967).

A generalization of the model given by Nocilla, by using "gas-surface interaction parameters," is discussed. Theory is applied to the problem of slip-flow boundary conditions when more than three parameters are necessary to represent the scattering by the surface. The important contribution to the temperature jump due to normal momentum accommodation is given for the first time. (auth)

19764 ON THE BEHAVIOUR OF A MOLECULAR BEAM SCATTERED BY A SOLID SURFACE: THEORETICAL STUDY FOR NORMAL INCIDENCE. Nocilla, Silvio; Chiado' Piat, Grazia (Politecnico, Turin). Entropie, No. 18, 132-7 (Nov.-Dec. 1967).

The authors study, by using a known theoretical method, the dependence of the velocity distribution of reflected particles on the incident-particle velocity distribution. This theoretical study is limited to normal incidence. (auth)

19765 STUDY OF THE REFLECTION OF MOLECULAR BEAMS OF ENERGY BETWEEN 100 eV AND SEVERAL keV ON A PLATINUM SURFACE EXPOSED AT DIFFERENT TEMPERATURES. Roustan, J. C.; Devienne, F. M. (Laboratoire Mediterraneen de Recherches Thermodynamiques, Nice). Entropie, No. 18, 127-31(Nov.-Dec. 1967). (In French).

The effect on the reflection of molecular beams, at energies from 100 eV to 7,500 eV, of the temperature of a platinum surface is studied. With argon and oxygen molecular beams, the reflection on a platinum tape heated to 1,400°C involves a speed dispersion decrease of the reflected molecules and an intensity increase in the specular direction. The lower the energy, the more important is the influence. In the hydrogen case, the temperature influence of the surface is less important. (auth)

19766 SOME COMMENTS ON THE REFLECTION OF MEDIUM-ENERGY NEUTRAL ATOMS. Medved, David B. (Electro-Optical Systems, Inc., Pasadena, Calif.). Entropie, No. 18, 123-6(Nov.-Dec. 1967).

A comparison was made of the interactions of ions and of atoms with a surface. It is shown that the differences existing between these two particle types are very large, especially in the case of a specular reflection. These differences increase when the energy of the particles decreases. (auth)

19767 THEORETICAL STUDIES ON THE INTERACTION OF RAREFIED GASES WITH THE SURFACE OF A SOLID BODY. INTERPRETATION OF DISTRIBUTION OF INTENSITY OF REFLECTED MOLECULAR BEAMS. Nikuradse, A.; Weidner, J. (Institut fuer Elektronen- und Ionenforschung, Munich). Entropie, No. 18, 119-22(Nov.-Dec. 1967). (In French).

The interaction of molecular beams with a solid surface is due to the impact of the gas atoms or molecules with the atoms and molecules of the solid surface. There is an interaction potential between the gas particles and the surface particles. These phenomena take place in the atomic range, and can be studied by quantum mechanics. With a calculation using wave mechanics, the scattering intensity distribution curve versus reflexion angle is theoretically explained for the case of a gas particle being scattered by a particle from the surface. (auth)

19768 EXPERIMENTAL STUDIES ON DISTRIBUTION OF INTENSITY OF REFLECTED MOLECULAR BEAMS AS FUNCTIONS OF ADSORPTION AND THE TEXTURE OF METALS. Graf, U.; Nikuradse, A. (Institut fuer Elektronen und Ionenforschung, Munich). Entropie, No. 18, 115-18(Nov.-Dec. 1967). (In French).

A device to measure the intensity distribution and the time of flight of a pulsed molecular beam is described. The change of the intensity distribution of the scattered gas molecules, in relation to the change of adsorption on the solid surface, is shown. The grain structure of the metal surface after a special mechanical treatment is shown to have an influence on the intensity distribution. (auth)

19769 EXPERIMENTAL STUDIES ON DISTRIBUTION OF INTENSITY OF REFLECTED MOLECULAR BEAMS AS A FUNCTION OF THE DEGREE OF ROUGHNESS OF BRASS SURFACES. Bark, P.; Nikuradse, A. (Institut fuer Elektronen- und Ionenforschung, Munich). Entropie, No. 18, 111-14(Nov.-Dec. 1967). (In French).

The scattering distribution of argon molecular beams on rough brass surfaces was studied. The molecular beam is collimated and modulated with a frequency of 350 Hz. The results concerning the relation of the loss of momentum and the roughness degree of the surface are given. The relation is linear in a wide range. (auth)

19770 AEROSPACE APPLICATIONS OF MOLECULAR BEAMS. INTERACTIONS AT THE WALL BOUNDARY. Hurlbut, F. C. (Univ. of California, Berkeley). Entropie, No. 18, 98-110(Nov.-Dec. 1967).

The transfer of momentum and of energy between gas particles and solid surfaces is discussed. Special emphasis is placed on distributions of reflected particle flux and velocity derived from molecular beam experiments of high or intermediate energy, although comparisons are made with results of work at lower energies. In these results, particularly at the high energies, Maxwellian re-emission behavior is not followed. The theoretical wall interaction model of Nocilla is discussed to make clear the usefulness of a parametric model of more generality. This theoretical model is applied to the calculation of aerodynamic stresses in free-molecular flows. The results of direct measurements on particular aerodynamic shapes are also discussed. (auth)

19771 QUANTUM EFFECTS IN HIGH-ENERGY ATOMIC COLLISIONS. Neumann, W.; Pauly, H. (Univ., Bonn). Entropie, No. 18, 93-7(Nov.-Dec. 1967).

The velocity dependence of the total scattering cross section for Na, K, and Cs atomic beams scattered by Ar, Kr, Xe, Hg, and Cs has been measured with an apparatus of high angular resolution in the energy range 6 to 2300 eV. The resolution of quantum effects results in a significant extension of previously available information about the interatomic potentials of these collision partners. (auth)

19772 DETERMINATION OF COLLISION CROSS SECTIONS OF TRIATOMIC HYDROGEN MOLECULES. Devienne, F. M.; Belliardo, J. J. (Laboratoire Mediterraneen de Recherches Thermodynamiques, Nice). Entropie, No. 18, 89-92(Nov.-Dec. 1967). (In French).

To compare the collision cross sections of molecules corresponding to the different molecular beams obtained by charge transfer of $^1H^+$, $^2H^+$, $^3H^+$ ions, the authors use an apparatus permitting separation of the different beams emerging from the ion sources. In a first device, the detector assigned to measure the intensity variation of the molecular beams after crossing the collision chamber is seen from the middle of the chamber under an angle of 1°. In the second, a more accurate device, this angle is only 10'. The collision cross sections are given for hydrogen and oxygen. The results show that the cross section corresponding to the neutralization of the triatomic hydrogen ion is different from the cross-section that one would obtain by assuming that H_3^+ is fully dissociated into H_2^+ and H_1^0. (auth)

19773 DETECTION AND SCATTERING CROSS SECTION FOR N_2 MOLECULES WITH ENERGIES IN THE RANGE 20 TO 200 eV. Nutt, C. W.; Mehendale, K. N. (Univ. of Birmingham, Eng.). Entropie, No. 18, 86-8(Nov.-Dec. 1967).

N_2 pulsed molecular beams with energies in the 20- to 200-eV range were obtained from low-voltage pulsed electrical discharges. The molecular beam is detected by measuring the secondary electron emission from a brass target. The use of an 18-stage electron multiplier as detector provides much better sensitivity and makes it possible to determine the molecular beam speed. The apparatus permits measurement of the scattering cross sections of N_2 molecules in gases such as Ar, O_2, N_2, CH_4, and C_2H_4. (auth)

19774 TOTAL CROSS SECTION MEASUREMENTS OF K ON RARE GASES IN THE THERMAL AND HIGH-VELOCITY RANGE. AN ATOM SOURCE IN THE ENERGY RANGE 0.5 TO 40 eV. Politiek, J.; Los, J.; Schipper, J. J. M.; Baede, A. P. M. (Institute for Atomic and Molecular Physics, Amsterdam). Entropie, No. 18, 82-5(Nov.-Dec. 1967).

To obtain a potassium molecular beam in the 0.5- to 40-eV range, the cathode sputtering process with high-energy ions is used. With a device consisting of an ion source of the unoplasmatron type, a velocity selector, a collision chamber and a detector, total cross sections in the thermal and higher-energy range were measured. In the latter range, the total cross sections were measured at velocities up to 10,000 m/s. The K total cross sections were determined in relation to helium and argon. (auth)

19775 DETERMINATION OF TOTAL COLLISION CROSS SECTIONS OF PARTICLES WITH ARGON ELECTRON CONFIGURATIONS WITH ARGON IN THE HIGH-ENERGY RANGE. Amdur, I.; Inouye, H.; Los, J.; Boerboom, A. J. H. (FOM–Instituut voor Atoom en Molecuulfysica, Amsterdam). Entropie, No. 18, 79-81(Nov.-Dec. 1967).

This work is carried out to determine the influence of the contraction of an electron cloud on the total collision cross section. A device is used very similar to Amdur's apparatus for measuring argon–argon total cross sections. Instead of a source of fast argon atoms, an ion source for producing K^+ ions is used. The results show a variation with energy of the total cross section which leads to an intermolecular potential function closely resembling that of -the argon–argon system. (auth)

19776 APPLICATIONS OF MOLECULAR BEAMS TO THE MEASUREMENT OF COLLISION CROSS SECTIONS AND TO THE DETERMINATION OF INTERMOLECULAR FORCES. Amdur, I. (Massachusetts Inst. of Tech., Cambridge). Entropie, No. 18, 73-8(Nov.-Dec. 1967).

Differences between the scattering of high-energy and thermal-energy molecular beams by neutral gas molecules are discussed. Classical mechanics is applicable to scattering of high-energy beams over a range of scattering angles greater than those for thermal beams. The high-energy beams are particularly suitable for studying repulsive intermolecular forces. The variation of their collision cross sections with apparatus geometry is useful for extending the ranges of interaction distance where these repulsive forces are valid. Potentials are given for various systems and applications of the results are discussed. (auth)

19777 CONDENSATION OF AN ATOMIC BEAM OF GOLD ON A MONOCRYSTALLINE SURFACE. Haymann, P.; Rodocanachi, P.; Meyer, M. (CNRS, Bellevue, France. Faculte des Sciences, Rouen). Entropie, No. 18, 68-72(Nov.-Dec. 1967). (In French).

By ion bombardment of a crystal target it is possible to obtain atomic beams at intermediate energy with a low divergence and an adjustable intensity. With an ion beam bombardment of 10-keV energy, 2 $\mu A/mm^2$ intensity, atomic beams are obtained. The energy of these beams is ~20 eV and the intensity is between 10^{13} and 2×10^{14} at/cm^2 s. This method provides reproducible thin layers of given content and perfectly oriented. (auth)

19778 DIFFERENT APPLICATIONS OF HIGH-ENERGY MOLECULAR BEAMS. Devienne, F. M. (Laboratoire Mediterraneen de Recherches Thermodynamiques, Nice). Entropie, No. 18, 61-7(Nov.-Dec. 1967). (In French).

Applications and research concerning solid physics and chemistry are presented. First, the secondary electron emission rate variation of a metal bombarded with a high-energy molecular beam is studied. Many parameters—outgassing, incident molecule energy, temperature and nature of the metal, nature and atomicity of the molecules, and incident angle—play an important part. The most important results concerning sputtering are then studied. The influence of the energy, nature, and atomicity of the incident molecules is shown. Finally, the chemical uses of molecular beams at high and intermediate energies are given. The conditions are stated by studying the formation of molecular beams of triatomic molecules, as hydrogen and nitrogen ones. (auth)

19779 PRODUCTION OF INTENSE MOLECULAR BEAMS BY DOUBLE EXTRACTION OF PURE OR SEEDED SUPERSONIC JETS. Campargue, Roger (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Entropie, No. 18, 55-60(Nov.-Dec. 1967). (In French).

A supersonic molecular beam source using relatively low pumping rates and producing high-intensity beams is described. The existence of self-scattering downstream of the skimmer is demonstrated by using seeded beams. This pre-extracting device thus appears to improve the efficiency of the molecular beam technique, the skimmer located between the nozzle and the collimator allowing two-stage pumping operation with reduced workload. (auth)

19780 METHODS USED AT THE LABORATORIE MEDITERRANEEN DE RECHERCHES THERMODYNAMIQUES FOR MEASUREMENT OF VELOCITIES OF MOLECULAR BEAMS OF WEAK INTENSITIES. Clapier, Robert (Laboratoire Mediterraneen de Recherches Thermodynamiques, Nice). Entropie, No. 18, 50-4(Nov.-Dec. 1967). (In French).

The principle of the molecular beam speed measurement is based on the time-of-flight determination by modulation of the primary ion beam originating a high-energy molecular beam by charge transfer. With a sampling device, it was possible to measure the argon molecular beam speeds reflected on a surface up to 500 eV. By using an electron multiplier, it was possible to measure reflected molecular beam speeds at energies ranging to about some tens of eV. With synchronous detection, it is possible to improve measurement sensitivity. (auth)

19781 PRELIMINARY RESULTS ON MOLECULAR BEAMS OF NITROGEN CLUSTERS. Coutant, J.; Fois, M.; Prevot, F. (EURATOM-CEA, Fontenay-aux-Roses, France). Entropie, No. 18, 47-9(Nov.-Dec. 1967). (In French).

In the device being used, the authors hope to obtain an electrically charged hydrogen cluster beam and accelerate to an energy of the order of 1 MeV per cluster. Then the ordinary ions resulting from the dissociation of the clusters in a confining magnetic field should provide a very high-temperature plasma. (M.O.W.)

19782 DENSITIES AND SPEEDS IN AN ARC-HEATED SUPERSONIC ARGON BEAM. Knuth, E. L.; Kuluva, N. M.; Callinan, J. P. (Univ. of California, Los Angeles). Entropie, No. 18, 38-46(Nov.-Dec. 1967).

Argon molecular beams at intermediate energies and high intensities are obtained by heating the beam gas in an electric arc and by converting the thermal motion into energy of directed motion in a supersonic free-jet. The performance of this facility has been measured and compared with the predicted characteristics of a model of molecular beams using a free supersonic jet. An energy of 2.7 eV was reached. It is hoped to reach higher energies by using a constricted arc. (auth)

19783 INTERMEDIATE ENERGY MOLECULAR BEAMS FROM FREE JETS OF MIXED GASES. Anderson, J. B. (Princeton Univ., N. J.). Entropie, No. 18, 33-7(Nov.-Dec. 1967).

Molecular beams in the 0.1- to 20-eV range are produced by the use of gas mixtures in supersonic jets. Beam intensities, velocities, and velocity distributions are measured. These data are compared with theory. It is particularly noted that, for the speed distribution measurement of heavy particles with helium, the temperature corresponding to the heavier molecules exceeds that of the light species. (auth)

19784 ENERGY DISPERSION OF IONS PRODUCED BY A HIGH-FREQUENCY EXCITATION SOURCE. Benoit-Cattin, P.; Bernard, L. C.; Bordenave-Montesquieu, A. (Faculte des Sciences, Toulouse). Entropie, No. 18, 29-32(Nov.-Dec. 1967). (In French).

The energy dispersion emerging from a radio-frequency ion source is studied. Concerning molecular beams emerging from such an ion source, this problem is very important. Generally, the energy spectrum consists of a main peak P with an energy nearly equal to the extraction potential with a width at the half-height below 100 eV. Then, there are one or several secondary peaks. The energy dispersion ΔE of the main peak has, for helium and argon, the same variation shape. The main peak height shows a maximum for an extraction potential between 1.5 and 2 kV. (auth)

19785 MEASUREMENT OF WEAK INTENSITIES OF MOLECULAR BEAMS OF ENERGY BELOW 100 eV. Devienne, F. M. (Laboratoire Mediterraneen de Recherches Thermodynamiques, Nice). Entropie, No. 18, 25-8(Nov.-Dec. 1967). (In French).

The different methods used for an accurate determination of the intensities of high-energy molecular beams are given. First, the total accommodation device is described, and its sensitivity at room temperature is given; then it is shown that the measurement of secondary emission currents from certain heated metals, such as platinum and tungsten, allows relative measurements with a very high accuracy. By using an electron multiplier for the determination of the secondary electron emissivity of heated metals, it is possible to measure very low intensities, up to 100 eV. For lower energy, it is possible to use the total accommodation device at very low temperature. At liquid hydrogen temperature, this apparatus provides the measurement of low intensities of molecular beams at energy equal to 10 eV. (auth)

19786 MEASUREMENT OF THE DENSITY OF A MOLECULAR BEAM BY ELECTRON SCATTERING. Audit, P.; Rouault, M. (Faculte des Sciences, Orsay, France). Entropie, No. 18, 22-4 (Nov.-Dec. 1967). (In French).

A device using a method to measure the molecular beam density obtained by the Kantrowitz and Grey process is described. An electron beam is directed perpendicularly to the molecular beam. The total intensity of the scattered electrons in relation to the position of the electron beam and of the beam axis is measured. Then, a number of experimental results obtained according to this method are given. (auth)

19787 MOLECULAR BEAM ENGINEERING AT INTERMEDIATE ENERGIES. Fenn, John B. (Yale Univ., New Haven). Entropie, No. 18, 11-21(Nov.-Dec. 1967).

Various methods of providing molecular beams at intermediate energies are described, i.e., from 1 to 25 eV. The different sources of molecular beams are based upon one of the following processes: ion sputtering, dipole acceleration, merged beams, mechanical acceleration, very high temperature, aerodynamic or electrostatic acceleration. The characteristics of each process are analyzed. Some results relative to the production of high-energy molecular beams are given. A bibliography includes the main papers concerning the generation of molecular beams at intermediate energies. (auth)

19788 CORRECTIONS TO MUONIC X RAYS AND A POSSIBLE PROTON HALO. Barrett, Roger C. (Univ. of California, Berkeley); Brodsky, Stanley J.; Erickson, Glen W.; Goldhaber, Michael H. Phys. Rev., 166: 1589-98(Feb. 25, 1968). (SLAC-PUB-335).

With the aim of extracting maximum information on nuclear charge structure at large distances, the theory of muonic x rays in ^{209}Bi is improved by taking into account all known effects which could change the binding energy by as much as 0.1%. Improved estimates are given of vacuum-polarization and Lamb-shift effects, incorporating Cole's recent estimate of nuclear polarization effects. Using these corrections to analyze recent experiments on muonic x rays, parameters are obtained for the charge distribution in ^{209}Bi which, when compared with parameters from electron scattering, indicate a small discrepancy. It is suggested that this can be explained by a proton "halo," by which is meant a small fraction of the charge (~1%) spread over large distances (~8F); it is shown that such a "halo" is not inconsistent with electron–proton scattering and brings the theory of the Lamb shift in atomic H and D into good agreement with experiments. No experiment is found with which such a model is inconsistent. (auth)

19789 CHARACTERISTIC ENERGY LOSS OF ELECTRONS TRANSMITTED THROUGH ARGON. Hale, G. C.; Hasted, J. B. (London Univ.). Nature (London), 217: 945-6(Mar. 9, 1968).

A Born–Bethe approximation zero-angle electron scattering energy loss search for unidentified levels in Ar was conducted, using a double 180° magnetic electron spectrometer. Typical Ar energy-loss spectra are shown and discussed for electrons of 1100-eV initial energy. An interesting feature was an unidentified peak at ~230 eV; it is suggested that this energy-loss peak could be caused by the collective excitation of a number of electrons. (UK)

19790 ELECTROMAGNETIC FIELD OF POINT SOURCE OF PENETRATING RADIATION ABOVE CONDUCTING PLANE IN AIR. Medvedev, Yu. A.; Stepanov, B. M.; Fedorovich, G. V. Zh. Tekh. Fiz., 37: 2084-8(Nov. 1967). (In Russian).

The electric and magnetic fields due to a point source of gamma radiation on an infinite conducting plane in air are calculated. The calculated fields are those due to the current of Compton electrons ejected from air molecules by the gamma rays, the conduction current in the air, and the current in the conducting plane. The Compton current is assumed to flow radially inward toward the source (the negatively charged Compton electrons move on the average radially outward from the source). It is assumed that both the magnitude of the Compton current and the conductivity of the air are proportional to $\exp(-\mu r)/r^2$, where μ is the absorption coefficient of the gamma rays and r is the distance from the source. Formulas are derived giving the electric and magnetic field components as functions of position in terms of definite integrals. It is found that the normal component of the electric field at the conducting plane is asymptotically proportional to r^{-4} for large distances r from the source. This unphysical result is due to the assumption that the ratio of the Compton current to the conductivity of the air is independent of r. (ATD)

19791 IONIZATION OF HIGHLY EXCITED ATOMS NEAR A METALLIC SURFACE. Chaplik, A. V. (Inst. of Physics of Semiconductors, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz., 54: 332-8(Jan. 1968). (In Russian).

The probability for ionization of a highly excited atom which slowly passes near a metallic surface is calculated. It is assumed that the distance from the metal greatly exceeds the orbit of the excited electron. (auth)

19792 EFFECT OF PSEUDO-INTERACTION OF TERMS ON ADIABATIC TRANSITIONS IN INELASTIC ATOMIC COLLISIONS. Kvlividze, V. A. (Inst. of Nuclear Physics, Moscow). Zh. Eksp. Teor. Fiz., 54: 250-4(Jan. 1968). (In Russian).

The probability for an adiabatic transition between two terms is calculated for the case when one of the terms has a "break" caused by pseudo-interaction with a third term. It is shown that at small velocities, when the "break" is still important, transitions in the break region should be taken into account. (auth)

19793 PERTURBATION THEORY FOR THE DIRAC EQUATION. Mikhailov, A. I.; Polikanov, V. S. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 54: 175-82(Jan. 1968). (In Russian).

A perturbation theory for the Dirac equation with a central electrostatic potential is developed by reducing the equation to the Rikkati equation. In this way the procedure of finding successive approximations in the perturbation parameter can be considerably facilitated. All corrections to the wave function and bound-state energy are expressed in terms of the unperturbed wave function and energy of the same state. As an example a calculation of the first approximation to the wave function and second approximation to the K electron energy is presented for the case when the perturbation is the deviation of the atomic potential from the Coulomb value. (auth)

19794 EXCITATION OF RYDBERG STATES IN HELIUM, NEON, ARGON, XENON, AND MERCURY ATOMS DUE TO ELECTRON COLLISIONS. Surskii, G. A.; Kupriyanov, S. E. (Karpova Physico-Chemical Inst., USSR). Zh. Eksp. Teor. Fiz., 54: 109-11(Jan. 1968). (In Russian).

An experiment on excitation of Rydberg (highly excited) states in helium, neon, argon, xenon and mercury atoms by electron impact is described. The ability of atoms in Rydberg states to ionize near a metallic surface and in an electric field is exploited for recording the states. Excitation curves are obtained for electron energies lying between the threshold value and 70 eV. (auth)

19795 CHARGE EXCHANGE INVOLVING AN EXCITED STATE. Poluektov, I. A.; Presnyakov, L. P. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 54: 120-6(Jan. 1968). (In Russian).

The effect of transition through an intermediate level on the charge exchange cross section when the atom is produced in the excited state is considered. It is shown that such a process may play an important role in the region of comparatively low velocities of relative motion. Calculations of the cross sections for the reactions $p + He \rightarrow H(2p) + He^+$ and $p + Ne \rightarrow H(2p) + Ne^+$ are in satisfactory agreement with the experiments. The possibility of using the results obtained for description of other atomic collisions, including transitions via an intermediate level, are considered. (auth)

19796 RATES OF TRANSITIONS BETWEEN NEON EXCITED LEVELS INDUCED BY ELECTRON COLLISIONS. Khaikin, A. S. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 54: 52-62(Jan. 1968). (In Russian).

The excitation rates per particle $\langle \sigma v \rangle$ for transitions between neon excited states induced by electron impact are measured by the modulation technique described earlier. Optical allowed ($4p'[\frac{3}{2}]_1 \rightarrow 4 + 6d'$) as well as forbidden ($5s'[\frac{1}{2}]_1^0 \rightarrow 4 + 6d'$) transitions are investigated. In accordance with the fact that the initial states are strongly excited, these rates considerably exceed those for transitions from the ground state. The results are interpreted and compared with the theory. (auth)

19797 DETECTION OF HIGHLY EXCITED HYDROGEN-LIKE STATES OF Ca^+, Sr^+, Ba^+, AND Mg^+ IONS. Kupriyanov, S. E. (Karpova Physico-Chemical Inst., USSR). Zh. Eksp. Teor. Fiz., 54: 16-18(Jan. 1968). (In Russian).

It is shown that in collisions between electrons and Ca, Sr, Ba or Mg atoms highly excited hydrogen-like states (Rydberg states) of singly charged ions are formed as a result of two processes: (1) stripping of one of the outer electrons and excitation of another to a state with a large principal quantum number n; (2) excitation of one of the inner electrons to a state with a large n followed by rapid autoionization. Rydberg states have been observed in doubly charged Ca^{2+}, Sr^{2+}, and Ba^{2+} ions. (auth)

19798 INTERACTION BETWEEN ATOMIC SYSTEMS IN CONDENSED MEDIA. Kaipov, D. K.; Kosyak, Yu. G.; Shubnyi, Yu. K. (Inst. of Nuclear Physics, Alma-Ata, USSR). Zh. Eksp. Teor. Fiz., 54: 19-24(Jan. 1968). (In Russian).

Nuclear γ-quantum resonance scattering is employed for determining the effective interaction range between recoil atoms and molecules of a condensed medium as a function of charge of the recoil nucleus. The measurements are carried out at energies from 10 to 200 eV. The dependence obtained is compared with calculations based on Bohr, Firsov, and Thomas–Fermi–Dirac potentials. The Firsov potential yields best agreement. (auth)

19799 SURFACE IONIZATION OF ALKALI METAL HALIDE MOLECULES ON PLATINUM-GROUP METALS. Zandberg,

E. Ya.; Tontegode, A. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 37: 2101-4(Nov. 1967). (In Russian).

A study was made of surface ionization of alkali halide molecules on platinum group metals. Results are presented on surface ionization of CsCl and LiCl molecules and Cs and Li atoms on surfaces of polycrystalline iridium. Molecular and atomic beams could be simultaneously directed onto the heated iridium wire; the beam fluxes were low, and under all the experimental conditions the ionization current recorded with both beams striking the iridium wire was equal to the sum of the ionization currents recorded when one or the other of the two beams was cut off. The threshold temperatures for surface ionization of both salt molecules (about 1850°K for CsCl and 1650°K for LiCl) were higher than those for the corresponding alkali metal atoms, and at temperatures above a certain threshold the surface ionization coefficient of the alkali metal in the salt was equal to that of the alkali metal atom (this coefficient was practically unity for Cs and about 0.7 for Li). The threshold temperature for surface ionization of CsCl depended strongly on the residual gas pressure (which was varied from 3×10^{-6} to 8×10^{-5} mm Hg), the threshold temperature being the higher, the higher the residual gas pressure. It is concluded that the sticking probability of CsCl and LiCl molecules on an Ir surface at temperature above the threshold is close to unity. The fact that the surface ionization of the molecules is low at temperatures below the threshold is ascribed to incomplete dissociation of the molecules at those temperatures, owing to rapid desorption. The residual gas pressure dependence of the surface ionization threshold temperature of the molecules indicates that the ratio of the dissociation rate to the desorption rate depends strongly on the condition of the adsorber surface, and it is suggested that the failure to observe ionization of alkali halide molecules on platinum surfaces is due to contamination of the platinum surface. (ATD)

19800 RESONANZFLUORESZENZ DER ATOMKERNE. (Resonance Fluorescence of Atomic Nuclei). Moessbauer, Rudolf L. Bremen, Germany, Angelsachsen Verlag, 1966. 24p.

A brief introduction is given to the collisionless nuclear resonance absorption. The theoretical and experimental study of the nuclear resonance absorption of γ radiation is outlined historically. The importance of new methods and the application to the area of nuclear physics and solid-state physics are discussed. Methods for the measurement of the relativistic effect are described. (J.S.R.)

Cosmic Radiation

Refer also to abstracts 19709, 19898, 20108, 20125, 20174, 20175, and 20202.

19801 SEASONAL VARIATION OF COSMIC-RAY INTENSITY AT A DEPTH OF 60 MWE UNDERGROUND IN LONDON. Dutt, J. C.; Thambyahpillai, T. (Imperial Coll. of Science and Tech., London). J. Atmos. Terrest. Phys., 30: 1-10(Jan. 1968).

An array of six vertical scintillation counter telescopes of semicubical geometry was operated continuously at a depth of 60 mwe underground during the period August 1963 to July 1964. After correction for barometer changes the data obtained show a seasonal variation of amplitude of about 0.2%, with the maximum intensity in May. An additional correction for the muon decay effect enhances the amplitude to about 0.3% and causes the maximum intensity to occur in June. A linear correction applied to allow for a possible solar cycle variation in the underground intensity modifies the results only slightly. Even though the corrected seasonal wave shows good positive correlation with the seasonal variation in the temperature of the atmospheric layer bounded by the 200 mb and 70 mb isobars, the interpretation of the seasonal wave in cosmic-ray intensity in terms of Duperier's positive temperature effect encounters some difficulty because the temperature coefficient yielded by the seasonal analysis has a significantly higher value (by a factor of about 1.7) than that obtained from the day-by-day analysis. The possible origin of this discrepancy is discussed. The seasonal wave in cosmic-ray intensity which is to be expected from the temperature data when Dorman's densities of temperature coefficients are utilized agrees fairly well with the observed seasonal wave, and this indicates that the latter may be entirely of atmospheric origin. Rainfall and geomagnetic activity do not show any close relationship with the cosmic-ray seasonal wave. (auth) (UK)

19802 ABUNDANCE OF NUCLEI HEAVIER THAN IRON IN THE COSMIC RADIATION IN THE GEOLOGICAL PAST. Price, P. B. (General Electric Research and Development Center, Schenectady, N. Y.); Rajan, R. S.; Tamhane, A. S. Astrophys. J., 151: L109-16(Mar. 1968).

One hundred and ninety-eight tracks of cosmic rays with $Z > 30$, produced during the last 5×10^7 years at a depth of ~1 cm in the Patwar meteorite, were studied. Estimates of atomic number, Z, were based on an improved relationship between etched track length and Z, derived from recent bombardments of meteorite crystals with Fe ions in an accelerator. After correcting for the difference in track-formation efficiency of cosmic rays of different Z, the value $[Z > 30]/[Fe] = 4.4 \times 10^{-4}$ was obtained for the ratio of the abundance of cosmic rays with $Z > 30$ to the abundance of Fe cosmic rays, averaged over the last 5×10^7 years. This is consistent with the latest estimate of the ratio of the universal abundances of the same group of elements, given by Cameron (1967) as 5×10^{-4}. Some implications and suggestions for future measurements are discussed. (auth)

19803 BAROMETRIC EFFECT FOR THE COSMIC-RAY PHOTON COMPONENT DEEP IN THE ATMOSPHERE. Chin, F. K.; Standil, S. (Univ. of Manitoba, Winnipeg, Can.). Planet. Space Sci., 16: 7-13(Jan. 1968).

The results of a study of the barometric effect on sea-level cosmic-ray photons with energies from 3.8 to 183 MeV, using a large NaI(Tl) crystal total absorption spectrometer, are presented. A simple regression analysis between hourly readings of photon intensity and pressure was used to determine the barometer coefficients (for various photon energies) for periods of 1 month, periods of 1 week, and short periods during rapid pressure changes. The energy dependence of the barometer coefficients was established and their seasonal variation investigated. (auth) (UK)

19804 SOLAR DIURNAL VARIATION OF THE COSMIC-RAY PHOTON COMPONENT DEEP IN THE ATMOSPHERE. Chin, F. K.; Standil, S. (Univ. of Manitoba, Winnipeg, Can.). Planet. Space Sci., 16: 15-20(Jan. 1968).

The results of a study on the solar diurnal time variation of near sea-level cosmic-ray photons with energies from 3.8 to 183 MeV, using a large NaI(Tl) crystal total absorption spectrometer, are presented. The variation found has a typical diurnal character for photons of energy up to about 50 MeV. Some evidence is presented for an energy dependence of the solar diurnal amplitudes and times of maximum. A comparison is made between the results for photons and those for neutrons over the same period of time. (auth) (UK)

19805 COSMIC-RAY ANISOTROPY IN THREE-DIMENSIONAL SPACE. Nagashima, K.; Duggal, S. P.; Pomerantz, M. A. (Franklin Inst., Swarthmore, Pa.). Planet. Space Sci., 16: 29-46(Jan. 1968).

A systematic cosmic-ray intensity gradient along the Earth's rotational axis, arising from a spatial anisotropy almost perpendicular to the plane of the ecliptic, was observed for the first time. Analysis of data recorded by a network of high counting rate neutron monitors during the recovery phase of a Forbush decrease in March 1966, revealed a significant north–south asymmetry. A theoretical model that accounts for all the observed effects, including the latitude dependence, is developed. The anisotropy is envisaged as arising from the diffusion of cosmic rays through disordered magnetic fields in the vicinity of the Earth, associated with a profusion of solar disturbances that were conspicuous during this period of resurgent solar activity. The two components of the vector in three-dimensional space that defines the direction of anisotropy were determined by combining the information deduced from the study of the north–south asymmetry with the associated diurnal variation. During one of the two epochs studied in detail, the greatest flux of cosmic-ray particles was incident from the direction in space $-83.5 \pm 3.5°$ declination and 13.3 ± 0.7 h right ascension. Thus, the configuration of magnetic fields of solar origin that enveloped the Earth at this time was not symmetrical about the equatorial plane. Alternative interpretations of this result are: (1) that the lines of force were temporarily directed almost perpendicularly to the solar equatorial plane, permitting preferential flow of particles along this direction; or (2) that the lines of force were parallel to the equatorial plane, as usual, and the density gradient in the north–south direction was a consequence of the unsymmetrical spatial distribution of the cosmic-ray "shield." (auth) (UK)

19806 ANCIENT COSMIC RAY TRACKS IN MICA? Craig, R.; Mamidzhanian, E.; Wolfendale, A. W. (Univ. of Durham, Eng.). Phys. Lett., 26B: 468-70(Mar. 4, 1968).

It has been suggested by Russell that some of the decorated lines seen in muscovite mica have been produced by charged particles. The present observations have failed to substantiate this suggestion. (auth)

19807 FRAGMENTATION OF HEAVY COSMIC RAYS IN THE GALAXY. Shapiro, Maurice M.; Silberberg, Rein (Naval

Research Lab., Washington, D. C.). pp 37-58 of High-Energy Nuclear Reactions in Astrophysics. Shen, B. S. P. (ed.). New York, W. A. Benjamin, Inc., 1967.

Within the source regions and in their subsequent journey through galactic space, cosmic nuclei are subject to many physical effects which alter their energy and sometimes their chemical identity. Among these effects are magnetic deflection, ionization loss, nuclear collision, and acceleration. Topics discussed include: path length and confinement time of cosmic rays, light elements in the primary radiation, ^{3}He in the primary radiation, ^{10}Be as a cosmic-ray clock, cross sections for fragmentation, the Be/B ratio and the age of cosmic rays, and separation of B isotopes (and other methods for estimating T). (W.D.M.)

19808 NEUTRON PRODUCTION BY COSMIC RAYS IN THE ATMOSPHERE. Korff, S. A.; Mendell, R. B. (New York Univ., N. Y.). pp 159-68 of High-Energy Nuclear Reactions in Astrophysics. Shen, B. S. P. (ed.). New York, W. A. Benjamin, Inc., 1967.

The phenomenon of the generation of neutrons by cosmic radiation during interactions with nuclei in the atmosphere has both astrophysical and geophysical implications. It is the purpose of this communication to review a few of the pertinent facts and to discuss some of the implications. Space and time preclude a complete treatment of either phase, but some interesting factors are pointed out. (W.D.M.)

19809 NUCLIDE PRODUCTION BY COSMIC RAYS IN METEORITES AND ON THE MOON. Kohman, Truman P.; Bender, Michael L. (Carnegie-Mellon Univ., Pittsburgh). pp 169-245 of High-Energy Nuclear Reactions in Astrophysics. Shen, B. S. P. (ed.). New York, W. A. Benjamin, Inc., 1967.

A survey is given of the observation of products and rates of nuclear reactions in thick solid targets produced by cosmic radiation in space and by protons artificially accelerated to high energies. Methods used previously for calculating nuclide production rates in meteorites and on the lunar surface are reviewed. These methods include calculations based on particle fluxes and nuclear cross sections, Monte Carlo calculations of intranuclear and internuclear cascades, and the translation of thick-target bombardment data to spherical bodies in an isotropic flux. In order to systematize the radiochemical data on nuclear reaction rates in accelerator bombardments of thick targets by collimated proton beams, a model was developed based on the assumption that production is due to two particle components, designated "stiff" and "diffuse." For each component the lateral distribution is represented by a two-dimensional diffusion function, and the depth dependence is given by a linear buildup function. The resulting equation has 10 parameters, which are evaluated by a least-squares analysis. This analysis was applied to 25 sets of data from iron targets at 4 proton energies, 0.45, 1, 3, and 6 GeV, and in all cases satisfactory fits were obtained. At each bombarding energy, six parameters were found to be similar for all products and were considered as "particle parameters." One is an artifact related to the finite width of the incident proton beam. Of the four "nuclide parameters," one was found to be the simple cross section at the incident proton energy for high-energy products, and somewhat larger for low-energy products. The other three were correlated with target–product mass-number difference. This enabled estimation of the parameters for other nuclides of interest, particularly ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, and ^{53}Mn. A procedure was developed for calculating production rates of nuclides at various depths in spherical iron meteoroids of various sizes exposed to isotropic cosmic radiation, using the nine pe: inent parameters at each of the four energies, and weighting each energy according to the integral galactic cosmic-ray-nucleon flux in corresponding intervals above 0.3 GeV per nucleon. Results are plotted for each of the five long-lived radionuclides mentioned. The calculated production rates were compared to observed specific activities in iron meteorites by correlation plots between pairs of nuclides: ^{10}Be–^{26}Al, ^{36}Cl–^{26}Al, ^{53}Mn–^{26}Al. Order-of-magnitude agreement is excellent, though there are many specific cases of disagreement. Several reasons for disagreement, including deficiencies in both the experimental data and the calculations, are discussed. Suggestions for improving and extending both are made. Applicability of this approach to thick-silicate-target bombardments, stone-meteorite data, and the lunar surface is mentioned. Experimental and theoretical work needed to improve our knowledge of cosmogenic nuclear reaction rates in solid objects is discussed. (auth)

19810 NUCLEAR CROSS SECTIONS REQUIRED IN STUDIES OF COSMIC RAYS. Reames, Donald V. (Goddard Space Flight Center, Greenbelt, Md.). pp 273-81 of High-Energy Nuclear Reactions in Astrophysics. Shen, B. S. P. (ed.). New York, W. A. Benjamin, Inc., 1967.

In order to make quantitative studies of interstellar propagation, complete information of the dominant spallation cross sections must be available. The cross section for breakup of a cosmic-ray nucleus, P, of energy/nucleon, E, into a secondary nucleus, S, in interstellar H is, of course, identical to that for the production of a nucleus, S, in the bombardment of a target, P, with a proton of kinetic energy E. If such cross sections can be measured in the laboratory or calculated with sufficient reliability, it may be possible to greatly increase the understanding of interstellar space, of the nature of the cosmic-ray source, and of the mechanism by which the particles are accelerated. In many cases, the interpretation of existing cosmic-ray composition data awaits this cross-section information. The purpose of this article is to call attention to the need for cross-section data. (W.D.M.)

19811 COSMIC RAYS IN THE INTERPLANETARY MAGNETIC FIELDS. Dolginov, A. Z.; Toptygin, I. N. (Ioffe Inst. of Physics and Tech., Moscow). Icarus, 8: 54-61 (Jan. 1968).

The propagation of cosmic rays in the regular and random interplanetary magnetic fields transferred by the clouds of the interplanetary plasma is considered. The equation for the distribution function is obtained. This equation is discussed in the diffusion and drift approximations and explicit solutions for some particular cases are found. The fluctuation of the solar wind velocity is taken into consideration. The study of cosmic rays is of great interest for magnetic field investigations. Up to now it is the only method for magnetic field studies in the distant part of the solar system. (auth)

19812 ENERGY CONCENTRATION IN THE EXPLOSION OF THE TUNGUS METEORITE. Zolotov, A. V. Zh. Tekh. Fiz., 37: 2089-94(Nov. 1967). (In Russian).

Microbarograms of the atmospheric waves initiated by powerful explosions and microbarograms from the explosion of the Bezymyannyi volcano on 30 March 1956, recorded at distances of 3560, 5560, and 42,250 km from the site, and microbarograms of the nuclear explosions in the Marshall Islands on 26 March, 25 April, and 4 May 1954, recorded at Shionomisaki, Japan are discussed. The microbarograms from explosions with low energy concentration (chemical and volcanic explosions) are characterized by a short duration of the disturbance and near independence (except for the amplitude) of the distance. The microbarograms from high-energy-concentration explosions, on the other hand, are characterized by a long duration that lengthens with increasing distance from the site. These differences are due to the fact that in chemical explosions, but not in nuclear ones, most of the energy in the atmospheric wave is concentrated in a narrow band of frequencies as a result of the oscillations of the large sphere of heated gas resulting from the explosion, and to the dispersion and absorption characteristics of the atmosphere. Microbarograms from the Tungus meteorite explosion of 1908, recorded at different distances up to 6000 km from the site, are presented and discussed. These microbarograms exhibit the characteristics expected from high-energy-concentration explosions and observed in nuclear explosions, and are very different from the microbarograms obtained from chemical and volcanic explosions. It is concluded that in the Tungus meteorite explosion of 1908 there was a high concentration of energy in a small volume. (ATD)

Direct Energy Conversion

19813 ANALYSIS OF THE DC MHD GENERATOR USING VECTOR DIAGRAMS. Celinski, Z. Arch. Elektrotech. (Warsaw), 16: 1021-37(1967). (In Polish).

The vector diagram technique is developed to investigate the relation between the vectors of the electrical quantities in a dc MHD generator. Basing on the generalized Ohm's law equation there have been found in the complex variable plane the loci of points ends of the vectors of electrical quantities for various Hall parameter and load factor values and for variable system of electrical connection of electrodes. The method developed here gives a pictorial presentation of the relationship between electrical quantities in the generator and permits their determination in the generator with arbitrarily connected electrodes. Constant gas dynamical parameters, constant magnetic field, and homogeneity of current density and electric field are assumed. (auth)

19814 CONDUCTIVITY OF A GAS WITH SUSPENSION AND ITS APPLICATION TO MHD GENERATION. Honma, Takuya Denki Shikenjo Kenkyu Hokoku, No. 666, 1-70(Oct. 1966). (In Japanese).

A discussion about the possibility of giving a required conductivity to the working fluid in an MHD generator using the thermionic emission from suspended powder of LaB_6. The result of analytical calculation shows that the electron density of 10^{14} cm^{-3} is attained

with powder density of 10^{13} cm^{-3} for the case of the LaB_6 solid particles of 10^{-5} radius at 2300°K. The conductivity of a mixture of nitrogen gas and powder of LaB_6 is calculated from the collision frequencies of an electron with solid particles and neutral molecules. The effect of the collisions is analyzed. The magnetohydrodynamic equations of the powder suspension gas are deduced from the microscopic properties and discussed. An analytic estimation for the design of an MHD power generator is performed, which is based on utilizing the gas with powder suspension. (M.H.R.)

19815 LOW-VOLTAGE CESIUM VAPOR ARC WITH A NON-ISOTHERMAL CATHODE. Busygin, E. P.; Grigor'yants, V. G.; Yavor, I. P. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 37: 2078-83(Nov. 1967). (In Russian).

The behavior of two identical cesium vapor diodes in the same envelope was investigated in order to obtain information concerning the influence on the operation of a cesium diode thermionic energy converter of a nonuniform temperature distribution on the cathode surface. The cathode of each diode was a 3 × 4 mm plane rectangular portion of a 4-mm-wide molybdenum strip that was heated by passage of a direct current. The two cathodes were mounted with their working surfaces in the same plane and with a 0.5-mm gap between their edges. Opposite each cathode there was mounted a plane anode. The two anode surfaces were coplanar, their edges were separated by a 0.5 mm gap, and the anode plane was parallel to the cathode plane and at a distance of 1.5 mm from it. The two diodes were enclosed in a glass envelope containing 0.5 to 1.0 mm Hg of cesium vapor. The cathode temperatures were measured with an optical pyrometer. The influence of the conditions in one of the diodes (cathode temperature and electrode potentials and currents) on the operation of the other was investigated. The temperature of the cathode of one diode considerably affected the diffusion current in and the ignition potential of the other one. Under arc conditions with the two anodes at the same potential, differences between corresponding anode and cathode currents revealed a flow of electrons in the plasma toward the region opposite the cooler cathode. The effect of the two diodes on each other was less marked when the current was high; for example, when the current density was 5 to 10 A/cm^2 extinguishing the arc in one diode reduced the current in the other by only a few percent. Electron density and temperature distributions in the interelectrode region were measured spectroscopically. It was found that connecting the two anodes together caused the electron density in the gap opposite the cooler cathode to increase, particularly in the region near the anode. It is concluded that a nonuniform distribution of temperature on the cathode surface of a thermionic energy converter can affect both the development of the arc and the behavior of the device after the arc is established. (ATD)

19816 COMBUSTION AND PROPULSION. Sixth AGARD Colloquium, Energy Sources and Energy Conversion, Cannes, France, March 16–20, 1964. DeGroff, H. M.; Hoglund, R. F.; Fabri, J.; Nagey, T. F.; Rumbaugh, M. E. Jr. (eds.). New York, Gordon and Breach Science Publishers, Inc., 1967. 934p. (In English and French). (AGARDograph–81).

Separate abstracts were prepared for 24 of the included articles. (M.O.W.)

For abstracts of individual papers see: 19817–19839 and 19981.

19817 NUCLEAR ENERGY SOURCE LIMITATIONS FOR DYNAMIC ENERGY CONVERSION SYSTEMS. Pittman, Frank K.; Lafleur, Joseph D. Jr. (Atomic Energy Commission, Washington, D. C.). pp 5-23 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph–81.

The limitations which the nuclear energy source imposes on the dynamic power system fall into two categories. First, because of the premium which the space environment places on high-temperature operation, materials throughout the system are called on to operate at high temperatures. Since the heat source must operate at the highest temperature of the cycle, the reactor fuel temperature is a potential limitation on cycle performance. Second, the nuclear radiation which accompanies the release of nuclear energy will require shielding of "hardening" to reduce the harmful effects on spacecraft components, and shielding to prevent injury to crews. The nuclear power plants will be the best, and in many cases, the only, means of meeting future space power needs. Therefore, these limitations and the associated development problems have been identified and are being solved. (auth)

19818 SOLAR COLLECTION LIMITATIONS FOR DYNAMIC CONVERTERS. Schrenk, George L. (Univ. of Pennsylvania, Philadelphia. General Motors Corp., Indianapolis). pp 25–46 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph–81.

A mathematical model for analysis of actual solar collectors has been developed. This model allows one to calculate the energy flux on any arbitrarily shaped focal surface from any arbitrarily shaped collector surface without making numerical approximations. Provisions are included for treating random surface errors on the reflector surface, orientation errors of any size, and vignetting of reflected light by a cavity opening. Typical results from this model are presented to show the effects of surface and orientation errors. This model has recently been used to investigate the interface between the collector and the heat receiver—the cavity opening. The directional assumption ordinarily made for this interface is that this opening can be treated as if it were a plane surface that emitted radiation according to Lambert's law (i.e., the cosine law). Results are presented that clearly show that this assumption is in substantial error for both perfect and imperfect collectors. Detailed analytical work has been performed on cylindrical heat receivers coupled with typical collectors. An "open cavity" Fredholm integral equation approach and the valid directional distribution have been utilized. The effects of the absorptivity and emissivity of the walls of the heat receiver have been investigated; reradiation losses and system performance have been calculated. The results presented differ significantly from the usual engineering estimates used in the design of solar power systems. (auth)

19819 RADIATOR DESIGN LIMITATIONS FOR DYNAMIC CONVERTERS. Koestel, Alfred; Smith, Cameron M. (Thompson Ramo Wooldridge, Inc., Cleveland). pp 49-109 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph–81.

The technology for design of radiators associated with dynamic converters in which the working fluid is condensed directly in the tubes of the radiator is reviewed. The general design procedure and its optimization are discussed. Various constraints, namely (1) condensing fluid mechanics, (2) radiation heat transfer from fins and tubes, and (3) meteorite protection are integrated through use of information flow charts indicating the sequence of computations. The appropriate equations and their source are noted. A method for estimating the optimum condensing temperature is explained and developed. The application of Lagrangian multipliers in the optimization of design is discussed. The fluid mechanics of the condensing process is described. Single-phase boundary layer stability techniques are applied to two-phase flow mechanics for purposes of predicting the transition of slow regimes. Experimental data which correlate wetting and nonwetting characteristics in the forced convection condensation of mercury are presented. Critical mercury drop size measurements at incipient entrainment are described and the conditions for "fog flow" of entrained liquid are defined. In conclusion, a review of problem areas of interest to designers of condensers for space power systems is presented. This review includes gravity effects such as: (1) runback (slugging) instability in vertical tubes; (2) horizontal tube gravity effects, and (3) the Rayleigh–Taylor instability. (auth)

19820 HEAT TRANSFER LIMITATIONS FOR DYNAMIC CONVERTERS. Fraas, A. P. (Oak Ridge National Lab., Tenn.). pp 111-34 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph–81.

Heat transfer considerations are major limiting factors in the design, development, and operation of dynamic conversion systems for space power plants. The nature of these limitations varies with the component. For example, in the heat source—whether nuclear or solar—thermal conduction affects the thermal stresses, thermal distortion, and local hot spots. These factors are likely to limit the practicable power density in the heat source to a lower value than might be permitted by the obvious problem of heat transfer from the heated solid surface to the fluid cooling it. The latter is likely not to be a difficult problem except for local hot spots caused by poor flow distribution or the like. Other heat transfer limitations include problems in the boilers and condensers for Rankine cycle systems and heat conduction, emission, and reflection in the radiator. This paper presents some typical examples of these problems that are particularly likely to be determining factors in the design of turbine–generator space power plants. (auth)

19821 PROSPECTS FOR THERMAL ENERGY STORAGE. Altman, Manfred (Univ. of Pennsylvania, Pittsburgh). pp 135-49 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph–81.

Methods of storing thermal energy by the utilization of the heat of fusion of suitable compounds are described. The incentives for the development of this type of energy storage are presented. The problems of synthesizing suitable materials and obtaining the needed heat transfer properties are discussed. (M.O.W.)

19822 NUCLEAR SOURCE LIMITATIONS FOR DIRECT CONVERSION DEVICES. Bussard, R. W. (TRW Space Technology Labs., Redondo Beach, Calif.). pp 257-77 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph–81.

Nuclear energy sources from solid-fuel fission reactors to eventual fusion reactors are considered for application to direct conversion. A brief review of system operating requirements provides a background for assessment of the potentialities and inherent physical limitations of these sources for direct conversion. Emphasis is placed on the characteristics of solid-fuel and gaseous-fuel fission reactors for application to thermionic and MHD conversion systems. Upper limits of operating temperature are shown to range from 2700 to 3700°C with the best solid fuels (U-loaded C to TaC and HfC) thus allowing Carnot cycle efficiencies of 50 to 65% to be considered for space applications and 80 to 90% of ground applications. For the former it is more important to achieve high cycle efficiency relative to Carnot efficiency than for the latter class of systems. The advantages of high-temperature source operation are negated unless high relative efficiency is achieved. Analysis of gaseous-fuel plasma production shows that the upper limit temperature capability depends upon the type of conversion cycle of interest (i.e. continuous flow vs pulsed operation), and that thermal radiation from the plasma becomes the dominant irreversible loss mechanism at extreme temperatures. Typically, peak temperatures of 10,000 to 40,000°K may be attainable. These potential upper limits are so high that Carnot efficiencies in the order of 90% are available, thus the principal problem of achieving high overall conversion efficiency rests with the choice of conversion cycle. In this circumstance it is difficult to separate the "limitations of nuclear sources" from those inherent to the operating cycle; an integrated systems view is required to achieve maximum overall performance. The power densities which characterize operation at these extreme temperatures are so high that systems of minimum feasible working size (from the standpoints of nuclear criticality and nonexcessive losses) must operate at thermal power levels of several tens of megawatts and above. Conversely, solid-fuel nuclear sources can be used effectively in conversion systems of a few tens of kilowatts (thermal). The eventual development of fusion reactors does not promise greater efficiency than from gaseous-fuel fission systems (again this depends almost entirely on the conversion cycle chosen) but simply changes the temperature levels of operation to much higher values (ca. 10 keV or 10^8 °K). This has the consequence that minimum practicable system thermal power levels may be several hundreds to thousands of megawatts. (auth)

19823 THERMODYNAMICS OF THERMIONIC ENERGY CONVERSION. Nottingham, W. B. (Massachusetts Inst. of Tech., Cambridge). pp 317-35 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph–81.

The contribution made to the understanding of thermionic energy conversion through thermodynamics is an example of one of the principal applications of this scientific discipline. First, it shows the broad outline of possibility and its bounds. It yields numerical results where details are not available. The next step toward the achievement of the practical application of the principle of energy conversion through thermionics demands a detailed understanding of many phenomena related to electron physics. A few of these may be enumerated as (1) properties of the thermionic emitter, (2) properties of the electron collector, and (3) ionization and excitation of gas (cesium) in the interelectrode space. Cesium vapor is most helpful as a substance in converter technology, since it adsorbs on refractory metal emitters such as tungsten or rhenium to lower the work function and thus permits the emission of a high electron current density. Cesium is easily ionized by two methods: (1) contact with the heated emitter surface or (2) collision with high-energy electrons. The ions reduce or eliminate the space-charge limitation of the available current. The collector work function is determined by its temperature, its base material and, most of all, by the adsorbed layer of cesium. (auth)

19824 PHYSICAL METHODS OF INVESTIGATION APPLIED TO THERMIONIC CONVERTERS. Kluge, W.; Bauer, K.; Bloss, W. (Institut fuer Gasentladungstechnik und Photoelektronik der Technischen, Stuttgart). pp 337-44 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph–81.

The efficiency, stability, and lifetime of thermionic converters are defined primarily by the surface properties of the emitter and collector materials. New methods for surface investigations are described. Included are studies of emitter material properties through the measurement of work function distributions by emission microscopy, the use of measured emitter resistance along with an energy balance to give overall effective work functions, and the measurement of evaporation rates by means of a quartz oscillator microweighing apparatus. A method of measuring the collector work function distribution, using an image orthicon tube with the storage plate replaced by collector material, is described. (auth)

19825 PROPERTIES OF EMITTERS AND COLLECTORS FOR THERMIONIC CONVERTERS. Picquendar, J. E.; Cahen, O. (Compagnie Francaise Thomson Houston, Bagneux, France). pp 345-55 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967. (In French).

See AGARDograph–81.

Research is reported on a thermionic converter without auxiliary electrode and using electronic emission and resonance ionization. Heterogeneous metal emitters are achieved by means of a mixture of tungsten and barium aluminate powders pressed at the bottom of a capsule; the collector is a molybdenum cylinder and a low-pressure cesium plasma is maintained between the electrodes. Tests performed with these converters promise a good efficiency source of energy operating at low temperature. (auth)

19826 ENERGY CONVERSION PROCESS STARTING WITH IONIZED VAPOR FROM FISSION PRODUCTS. Klein, Siegfried; Kraus, Pierre (CEN, Saclay, France). pp 357-74 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967. (In French).

See AGARDograph–81.

When two electrodes maintained at different temperatures are immersed in ionized vapor, a potential difference appears between them. Tests have been performed in a nuclear reactor channel where the predominating ionizing agent is constituted by the fission products released by a thin layer of uranium oxide. Experience has shown that in this conversion process the negative charge carriers are not constituted by electrons only but also by negative ions or negative droplets. Further experimentations should permit the development of these converters. (auth)

19827 DIAGNOSTICS OF PLASMAS. Thornton, John A.; Warder, Richard C. Jr.; Cambel, Ali Bulent (Northwestern Univ., Evanston, Ill.). pp 377-418 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph–81.

In energy conversion processes, both natural and man-made plasmas may be used to advantage. However, regardless of origin, it is necessary to know the properties of plasmas before reliable energy conversion devices can be designed and constructed. Theoretical considerations underlying plasma diagnostic techniques used in the Gas Dynamics Laboratory in conjunction with a variety of plasma generation facilities are discussed. (auth)

19828 THERMODYNAMICS OF MHD ENERGY CONVERSION. DeGroff, Harold M. (Purdue Univ., Lafayette, Ind.); Hoglund, Richard F. pp 419-75 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph–81.

Previous theoretical and experimental work is reviewed with an overall view of assessing the accuracy to which the performance of MHD conversion devices can be predicted. Both open- and closed-cycle linear MHD generators are discussed. The

recent progress made in open-cycle generators, with combustion reactions serving as the heat source, is described. Equilibrium thermodynamics is used to determine the theoretical performance of these generators. Particular attention is given to the loss mechanisms at the edges of the field regions and through the wall and electrode boundary layers. Existing experimental results are compared with the theoretical predictions. Major engineering problems are pointed out and discussed. In the case of closed-cycle generators, successful operation depends upon achievement of adequate electrical conductivity at relatively low temperatures. The most promising approach is through nonequilibrium ionization. The thermodynamic energy exchange processes which govern the extent of nonequilibrium ionization are discussed. Future prospects for development and key research areas pertinent to closed-cycle MHD power generation are described. (auth)

19829 NONEQUILIBRIUM MODES OF MHD CONVERTERS. Fells, Ian (Univ. of Newcastle-upon-Tyne, Eng.). pp 477-500 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph-81.

The classical linear-flow, crossed-field MHD generator can be made to operate with about 10% conversion efficiency but had inherent defects. Probably the most serious problems stem from the high temperatures necessary to maintain the conductivity of the driver gas stream by thermal (i.e., usually equilibrium) ionization of a seed material introduced into the gas stream. In open-cycle systems failure of electrode and dust materials occur, and heat transfer to the magnet system causes loss of efficiency. Breakdown of the electrical insulation properties of the refractories also takes place. In closed-cycle systems using a nuclear pile as heat source, the temperatures required for thermal ionization are unlikely to be realized in present or future designs of piles. A variety of approaches to the problem can be adopted. The reaction zones of hydrocarbon flames exhibit marked departure from equilibrium and, associated with this, ionization levels one million times greater than the predicted equilibrium values. This process is incompletely understood but phased combustion aimed at promoting this effect can lead to systems in which seed material is unnecessary. Oscillating combustion systems operating at both low and high frequencies lead to periodic high ionization levels with a low time-averaged temperature. Combustion driven detonations can be maintained in various modes; the spinning mode seems particularly useful for MHD power generation. In addition to lowering the time-averaged temperature, the operation of pulsed systems makes possible the generation of alternating rather than direct current. This type of system can be further elaborated by the design of linked cycle systems in which the conductivity generating process is linked to, but not the same as, the driving cycle. The freezing of equilibrium during expansion can lead to high conductivity at lower temperatures; such an effect is applicable to closed- as well as open-cycle systems. Ionization can be promoted by using an external ionizing source. A beam of ionizing radiation or electrons can be used to create dense plasma in phased combustion systems. The addition of electrical energy in the form of arcs, diffuse discharges, and hf modes to increase conductivity can be applied both to combustion systems and closed-cycle, seeded, inert gas systems. (auth)

19830 A NONEQUILIBRIUM ELECTRON MODE FOR KILOWATT-RANGE MPD SPACE POWER. McNab, I. R. (International Research and Development Co., Ltd., Newcastle-upon-Tyne, Eng.). pp 501-15 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph-81.

Many techniques for producing extrathermal ionization in magnetoplasmadynamic (MPD) generators are currently under investigation in the hope that reductions in the operating temperature of these generators will result. This is particularly important in the nuclear closed-cycle concept, which is of interest for space power systems, where the available gas temperature is limited by foreseeable nuclear reactor developments. One method of producing electron concentrations considerably greater than for thermal equilibrium is to rapidly expand the working fluid by means of a nozzle. This effect is investigated here, particular attention being paid to its influence on MPD generators in the range 10 to 100 kW output. (auth)

19831 POTENTIALITIES OF DIRECT ELECTROFLUIDDYNAMIC ENERGY CONVERSION PROCESSES FOR POWER GENERATION. Von Ohain, Hans; Wattendorf, Frank. pp 541-61 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph-81.

A general review is given of fundamental thermodynamic and electrical aspects of EFD conversion processes, including discussions on viscous coupling phenomena and generation of ions and charged colloids. (M.O.W.)

19832 PERFORMANCE CHARACTERISTICS OF ELECTROFLUIDDYNAMIC ENERGY CONVERSION PROCESSES EMPLOYING VISCOUS COUPLING. Lawson, Maurice O. pp 563-80 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph-81.

The performance characteristics of EFD conversion processes employing viscous coupling between the neutral molecules and the electrically charged particles are determined. Specifically, the conversion efficiency and other EFD performance values are determined, taking into account the effects of the physical properties of the working medium, the influence of geometric parameters, and scaling. (M.O.W.)

19833 PERFORMANCE CHARACTERISTICS OF ELECTROBALLISTIC GENERATORS. Hasinger, Siegfried. pp 581-601 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph-81.

The various limitations encountered in the realization of the principle are discussed. (M.O.W.)

19834 ION GENERATION BY CORONA DISCHARGE FOR ELECTROFLUID ENERGY CONVERSION PROCESSES. Lawson, Maurice O. pp 603-12 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph-81.

The possibilities of generating unipolar ions or charged colloids in high-speed gaseous working media used in electrofluiddynamic energy conversion processes are discussed. (M.O.W.)

19835 EXPERIMENTAL TECHNIQUES IN ELECTROFLUIDDYNAMIC ENERGY CONVERSION RESEARCH. Hawes, Michael. pp 613-30 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph-81.

The following topics were investigated: (1) closed-cycle or simulated closed-cycle operation, (2) methods of generation of ions or charged colloids of one polarity employing corona discharge, (3) effects of the geometric configuration of the conversion section and determination of scaling characteristics, (4) effects of variation in pressure in the conversion section, and (5) equipment and instrumentation for high-voltage, low-current, power measurements. (M.O.W.)

19836 THERMODYNAMICS OF THERMOELECTRIC CONVERSION. Ferro, V. (Politecnico di Torino, Turin). pp 633-49 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph-81.

After an examination of the experimental thermoelectric phenomena, their interpretation and correlation is made, according to the thermodynamic theory of irreversible processes. The case is then considered of an ideal thermoelectric generator, operating at optimum efficiency or at maximum electric power output conditions. (auth)

19837 HIGH-TEMPERATURE THERMOELECTRIC MATERIAL LIMITATIONS. Kelley, C. M.; Szego, G. C. pp 651-77 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16–20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph-81.

The characteristics of materials set many limits on their use in thermoelectric generators, the limiting factors varying in importance from one material to another. The Seebeck generator demands an extrinsic or mixed valence semiconductor. The onset of intrinsic conduction generally sets a limit at a temperature $T = 1000\ E_g$, where E_g is the band gap in eV. Mixed valence semiconductors are not limited in this sense. All semiconductors are limited by vapor or decomposition pressure at sufficiently high temperatures. This may be roughly estimated from the heat and entropy of vaporization, related in turn to structure and bond strength. The relation of bond strength to band gap is very ap-

proximate as presently known. The solubility of contact materials and diffusion of solutes prevents the use of many extrinsic semiconductors above the Tammann temperature, about 0.8 T_m. Certain mixed valence semiconductors have shown adequate thermoelectric properties in the liquid state. The modules are most frequently limited by the mechanical stability of the contacts. Spring loading for high-temperature application requires some device complications. Radiative heat transfer need not be a serious problem below 1800°K. Above this temperature it may seriously impair efficiency. Because of the limited range of peak performance of individual materials, efficient devices will require graded materials or some degree of staging. At high temperatures the materials stability problem will force this to be staging. Overall it appears that thermoelectric devices may be ultimately developed to operate at temperatures as high as 2000°K. (auth)

19838 QUANTUM EFFICIENCY OF RADIANT-ENERGY PHOTONS IN SEMICONDUCTORS. Jain, G. C. (Rice Univ., Houston, Tex.). pp 843-61 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16-20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph-81.

The efficiency of conversion of radiant energy from the sun, nuclear, or fossil fuels to electrical energy depends upon the efficiency with which a radiant energy photon is capable of generating a useful charge carrier. Using Shockley-Read statistics a general expression for the quantum efficiency of a monochromatic incident radiant photon has been derived in terms of the absorption coefficient $(L_\lambda)^{-1}$ of the incident wavelength in the semiconductor material, the minority carrier lifetime and the thickness of the exposed layer of the p-n cell. Germanium cells show a great potential for solid-state conversion of energy from radiant sources. An analysis of the results for germanium cells indicate that there is a strong dependence of the quantum efficiency on the thickness of the exposed layer. Assuming an n-p cell, quantum efficiencies of 90% and higher could be obtained for all wavelengths from very small values to 1.5×10^{-4} cm, if the thickness of the exposed n layer is kept in the range of 50 to 250 μ. For monochromatic wavelengths greater than 1.5 μ but less than 1.77 μ, the cutoff wavelength for Ge, the quantum efficiency decreases rapidly with increasing wavelength. It would, therefore, seem desirable that the radiant-energy photons of wavelengths 1.6 to 1.77 μ be reflected back and conserved. Because of the unavoidable impurities in the cell, the lifetime of minority charge carriers is reduced. A reduction in lifetime reduces the quantum efficiency. Variations of the optimum thickness of the exposed layer has been worked out for various values of minority carriers's diffusion lengths. (auth)

19839 PHOTOVOLTAIC CELLS WITH CONCENTRATORS. Leclerc, Pierre (Compagnie generale de Telegraphie, Fil Puteaus, France). pp 863-71 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16-20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967. (In French).

See AGARDograph-81.

Effect of development and operational parameters of a photodiode on its photovoltaic efficiency is discussed. The effect of the series resistance on generator efficiency and of possible means of improving cell performance was investigated. (auth)

Fluid Physics

19840 (D-1-82-0659) A BRIEF REVIEW OF THE LITERATURE CONCERNING THE STABILITY OF THE INTERFACE BETWEEN TWO FLUIDS IN RELATIVE MOTION. Gerwin, Richard A. (Boeing Scientific Research Labs., Seattle, Wash. Plasma Physics Lab.). Oct. 1967. 26p.

The stability of a plane interface between two fluids is reviewed. Various applications of the problem are discussed. (M.O.W.)

19841 INTEGRAL SOLUTION OF SOME PROBLEMS ON DISTRIBUTION OF PLANE JETS OF CONDUCTING FLUID. Dzhaugashtin, K. E. (Military Navy Engineering School, Leningrad). Inzh.-Fiz. Zh., 14: 129-33(Jan. 1968). (In Russian).

The problems on spreading free and semi-infinite wall jets in a uniform magnetic field are studied considering the change of conductivity across the jet. The equations of a plane laminar boundary layer are used as reference ones with the presence of the volume force ($Re_m \ll 1$). The solutions are obtained by the integral method. (auth)

19842 EXPERIMENTAL STUDIES OF DISTRIBUTION OF THE RATE OF FLOW OF CONDUCTING FLUID IN RECTANGULAR CHANNELS IN TRANSVERSE MAGNETIC FIELDS. Branover, G. G.; Gel'fgat, Yu. M. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza., No. 1, 79-83(Jan.-Feb. 1968). (In Russian).

Experimental data are given on velocity distribution of mercury flow in two rectangular, identical cross section channels with different conductivity, placed in a homogeneous transverse magnetic field. In the first channel the walls perpendicular to the field were nonconductive and the walls parallel to the field were highly conductive. The second channel had all highly conducting walls. The results show that with Reynolds numbers R = 40,200 and R = 25,300, flow rates are 20 and 12.6 cm/sec, respectively. (R.V.J.)

19843 HALL EFFECT INFLUENCE ON THE DEVELOPMENT OF TWISTED MAGNETOHYDRODYNAMIC FLOW IN A PLANE CHANNEL. Alavidze, G. R. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza., No. 1, 72-8(Jan.-Feb. 1968). (In Russian).

Previous studies of heat transfer of partially ionized gas revealed that conducting gas flow in a round tube placed in a magnetic field is a function of the magnetic field magnitude and its orientation (i.e., with magnetic field orientation parallel to the velocity of flow, the heat transfer is reduced 15% and with orientation antiparallel it is reduced 1%, as compared to the flow in the absence of magnetic field). An attempt is made here to explain the effect by analyzing processes taking place in twisted flow of anisotropic conducting media. An approximation is constructed, consisting of the equations of motion and equations of electrical potential. (R.V.J.)

19844 SHOCK WAVE INTERACTION WITH MAGNETIC FIELD IN A FINITE CONDUCTIVITY MEDIUM. Volosevich, P. P.; Kurdyumov, S. P.; Popov, Yu. P. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza., No. 1, 67-72(Jan.-Feb. 1968). (In Russian).

The complete system of one-dimensional equations was obtained for unsteady MHD flow, with finite conductivity and nonlinear temperature dependence. Results of special analytical solutions obtained for simplified conditions are also presented. The dependence of dynamic processes on magnetic field intensity was considered, along with variations of the conductivity with temperature. (R.V.J.)

19845 BOUNDARY LAYER ON A FLAT PLATE IN PRESENCE OF STRONG LONGITUDINAL MAGNETIC FIELD. Baranov, V. B.; Kartalev, M. D.; Masyakin, N. E. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza., No. 1, 4-11(Jan.-Feb. 1968). (In Russian).

The influence of a magnetic field on the boundary layer in a flat plate, streamlined considerably by strongly ionized gas, was investigated. The magnetic field is parallel to the plate and to the incoming flow and is so strong that the transfer coefficient becomes anisotropic (the cyclotron rotational frequency of the charged particles is larger or of the same order as the frequencies of their collisions). It is shown that in the presence of a strong longitudinal magnetic field, a sufficiently high degree of gas ionization can result in a reduced thermal flow on the plate. At low ionization such effect is very weak due to the viscosity and heat conductivity which, in such a case, are determined by the neutral gas component. Numerical data are given for the problem taking into account the transfer coefficients from thermodynamic parameters. In all cases it was accepted that the magnetic Reynolds number is ($R_m \ll 1$). (tr-auth)

19846 EXPERIMENTAL STUDIES IN MAGNETOFLUIDDYNAMICS: PRESSURE DISTRIBUTION MEASUREMENTS AROUND A SPHERE. Maxworthy, T. (California Inst. of Tech., Pasadena). J. Fluid Mech., 31: 801-14(Mar. 18, 1968).

Measurements of the pressure distribution around a sphere placed in aligned magnetic and velocity fields show that an increase in drag is mainly due to a decrease in the pressure on the base of the body. When magnetic forces are large compared to inertia forces, this decrease is due to a loss in total pressure along streamlines just outside the surface boundary layer and an acceleration of the flow to a velocity much larger than the reference velocity. Separation of a viscous boundary layer takes place behind the equator and still, to a large extent, controls the magnitude of the base pressure and the drag experienced by the sphere. A model consistent with these findings is presented. (auth) (UK)

19847 SOME ELECTRICALLY DRIVEN FLOWS IN MAGNETOHYDRODYNAMICS. PART I. THEORY. Hunt, J. C. R. (Central Electricity Research Labs., Leatherhead, Eng.); Williams, W. E. J. Fluid Mech., 31: 705-22(Mar. 18, 1968).

The magnetohydrodynamic flow between two parallel conducting planes is investigated for the case when the flow is driven by the current produced by electrodes placed one in each plane, the applied magnetic field being perpendicular to the planes. An exact

solution is presented for the case of line electrodes placed opposite each other, and an approximate method of determining the flow in this case for large Hartman number (M) is also given. It is shown that for large M the asymptotic form of the exact solution agrees with that obtained by the approximate method. The results are generalized to cover the case of line electrodes displaced relative to each other. A similar investigation is carried out for the case of two point electrodes opposite each other. (auth)

19848 ANALOG OF PRANDTL–MAYER FLOW IN MAGNETIC FIELD PARALLEL TO THE VELOCITY FIELD. Tsepilevich, V. G. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 101-3(Sept.-Oct. 1967). (In Russian).

A vortex problem in plane flow of ideal infinitely conducting gas is resolved, considering adiabatic processes in the magnetic field parallel to the velocity field. An analog was obtained for L. I. Sedov's (Hydrodynamics and Aerodynamics Plane Problems. Gostekhizdat, 1950) equation in the plane of pressure–current function variables; criterion of the existence and the equation for generalized Prandtl–Mayer currents were found, and a solution obtained for the transonic region. A method is suggested for constructing similar currents for streamlining certain profiles by a compressed fluid flow. (R.V.J.)

19849 ON THE DIFFERENTIAL EQUATION GOVERNING THE REAR STAGNATION POINT IN MAGNETOHYDRODYNAMICS AND GOLDSTEIN'S "BACKWARD" BOUNDARY LAYERS. Leibovich, S. (Cornell Univ., Ithaca, N. Y.). Proc. Cambridge Phil. Soc., 63: 1327-30(Oct. 1967).

Existence and uniqueness proofs for a boundary-value problem associated with a magnetohydrodynamic Falkner–Skan equation are presented. Relevant special cases of the problem considered include the magnetohydrodynamic rear stagnation point flow, and the non-magnetic "backward boundary layers" of Goldstein. (auth)

19850 CLASS OF EXACT SOLUTIONS OF THE MAGNETOHYDRODYNAMIC EQUATIONS. Wang, Chang-yi (California Inst. of Tech., Pasadena). Phys. Fluids, 11: 529-33(Mar. 1968).

A class of exact solutions of the full, viscous magnetohydrodynamic equations are generalized. This class of solutions has the property that the nonlinear terms in the governing equations are not zero identically but as a whole they cancel each other such that the remainder is linear and solvable. The governing equations are formulated using general orthogonal coordinates. Examples in Cartesian coordinates are illustrated. These exact solutions represent a wide variety of flows with probable astrophysical or engineering applications. In each case, the velocity field and the magnetic field are completely coupled. (auth)

19851 HEAT TRANSFER IN ALIGNED-FIELD MAGNETOHYDRODYNAMIC FLOW PAST A FLAT PLATE. Tan, C. W.; Wang, Carl C. T. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Int. J. Heat Mass Transfer, 11: 319-29(Feb. 1968).

Studies are presented of the steady-state heat-transfer phenomena in an aligned flow past a semi-infinite flat plate in which the flow velocity and magnetic field vectors far from the plate are parallel. A viscous, electrically conducting, incompressible fluid is used as the working medium. For simplicity, the physical properties are assumed constant and the electric field is taken to be zero. It is found that increasing the magnetic field increases the viscous, magnetic, and thermal boundary-layer thicknesses. The rate of heat transfer, however, is decreased with increasing magnetic field for Eckert number $Ek \leq 0$, while for $Ek > 0$ the opposite trend is observed. For $Ek \leq 0$ the rate of heat transfer is higher at a larger Prandtl number, while for $Ek > 0$ lower values of Prandtl number give higher heat-transfer rates. The predicted heat-transfer results are outlined in this analysis. (auth) (UK)

19852 FLOW OF A PERFECTLY CONDUCTING FLUID IN THE PRESENCE OF A THIN PROFILE. Dragos, Lazar. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 42: 381-9 (Mar. 1967). (In Italian).

The flow of a perfectly conducting compressible fluid over a thin cylinder, in the presence of a constant magnetic field, is considered. (tr-auth)

Geophysics

Refer also to abstract 18977.

19853 (RAE-TR-67201) SOLAR FLARE EFFECTS AND VLF RADIO WAVE OBSERVATIONS OF THE LOWER IONOSPHERE. Burgess, B.; Jones, T. B. (Royal Aircraft Establishment, Farnborough (England)). Aug. 1967. 20p. Dep.

The observed changes of phase and signal amplitude of vlf radio waves, propagated over distances varying between 1000 and 10000 km, which accompany solar flares were studied for the period 1961–1964. In general, the phase of the received signal advances and the signal amplitude increases during the onset of a solar flare. Observations of the GBR (Rugby) transmissions at Rome (1500-km path), however, show that for this particular path the phase of the received signal retards, in contrast to all other paths studied. Assuming that the conductivity of the lower ionosphere varies exponentially with height under both quiet and disturbed conditions, it is possible to evaluate the waveguide mode characteristics of vlf propagation over large distances. Using this theoretical approach it is shown that the observations can only be interpreted if both the D-region electron density profile is lowered and the gradient of ionization density increased. The magnitude of the flare-produced changes in ionization density profiles of the lower ionosphere were evaluated analytically from solar x-ray data. These profile changes are consistent with the lowering of the D region and increase in ionization gradient that are required to explain the vlf radio wave observations. (auth) (UK)

19854 CYCLOTRON AND CHERENKOV MECHANISMS FOR EXCITING HYDROMAGNETIC RADIATION IN THE MAGNETOACTIVE PLASMA. Kato, Yoshio; Higuchi, Yoshihiro (Tohoku Univ., Sendai). Sci. Rep. Tohoku Univ., Fifth Ser., 19: 1-17(June 1967).

The ray and group refractive indices are derived for the propagation of hydromagnetic waves in the magnetoactive plasma. These refractive indices are applied to the calculation of the radiation emitted by a single charged particle (proton) gyrating with velocity V in the static magnetic field H_0. The hydromagnetic radiation is possible by the cyclotron and the Cherenkov mechanisms when the proton velocity exceeds the phase velocity of the emitted hydromagnetic waves (superluminous velocity). The relation can be found between the ratio of the Alfvén wave velocity to the proton velocity and that of the gyrofrequency of a proton to the angular frequency of the hydromagnetic waves if a particular value is assigned to the angle between the direction of the propagation of waves emitted and proton velocity. The results are applied to the hydromagnetic emissions in a simple model of the magnetosphere. In order to emit hydromagnetic waves in the frequency band of about 1 cps the kinetic energy of a proton is required to be about 200 keV to MeV for the cyclotron excitation and about 3 to 10 keV for the Cherenkov excitation in the vicinity of the equatorial plane at 4 R_E (earth radii). (auth)

19855 EFFECT OF MICRO-INSTABILITY ON THE TEMPERATURE ANISOTROPY IN THE SOLAR WIND. Kato, Yoshio; Watanabe, Shigeaki (Tohoku Univ., Sendai). Sci. Rep. Tohoku Univ., Fifth Ser., 19: 19-32(June 1967).

Recent observations show that the solar wind plasma has a thermal anisotropy in a reference frame moving with the convective velocity. A rough estimate of anisotropic thermal velocities can be made if the anisotropy is produced by a combination of the collisional redistribution process and the increment of an anisotropy due to the conservation of the first adiabatic invariant. The velocity distribution estimated here is much more anisotropic compared with the observations by space vehicles. This discrepancy suggests that there must be some processes which are more effective in redistributing velocities than the collisional process. In the hydromagnetic analysis, it has been generally considered that the gardenhose (GH) instability is caused by the anisotropy of the velocity distribution in the interplanetary plasma. When right-hand polarized waves (R mode) come into resonance with protons in the tail of the anisotropic velocity distribution, R-mode instability breaks out due to a perturbation. The quasilinear treatment leads to the conclusion that beside the GH instability, the R-mode instability can control the temperature anisotropy. The GH instability can be caused when the pressure ratio β exceeds 2, while the R-mode instability takes place when $\beta \geq 0.7$. (auth)

19856 WINDS AND ELECTROMAGNETIC DRIFTS IN THE EQUATORIAL F2 REGION. Bramley, E. N.; Young, Margaret (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 30: 99-111(Jan. 1968).

Previous calculations of steady-state electron density distributions in the equatorial ionosphere are extended to study the effect of variations in the electromagnetic drift velocity. It is found that a very small downward drift is sufficient to destroy the equatorial anomaly. The effects of meridional winds in producing distributions which are asymmetrical about the equator are studied, and from a comparison with experimental data it is suggested that such winds can well account for the asymmetrical distributions found at the solstices. The effects of asymmetrical photoionization and heating of the neutral air are insufficient to explain these solstice results. (auth) (UK)

19857 RECTILINEAR MODEL OF CONJUGATE F REGIONS. Cummack, C. H. (Geophysical Observatory, Christchurch, New Zealand). J. Atmos. Terrest. Phys., 30: 125-34(Jan. 1968).

A linearized F-region model is presented in which the loss rate varies as e^{-2z}, the conjugate region is treated as an extension of the region considered, and free diffusive transport of ionization is allowed. It is found that transport of ionization between conjugate regions does not greatly modify the derived ionization profiles. (auth) (UK)

19858 MEASUREMENTS OF D-REGION ELECTRON DENSITIES DURING THE INTERNATIONAL QUIET SUN YEARS. Thrane, E. V.; Haug, A.; Bjelland, B.; Anastassiades, M.; Tsagakis, E. (Norwegian Defence Research Establishment, Kjeller. National Observatory of Athens). J. Atmos. Terrest. Phys., 30: 135-50(Jan. 1968).

Some height distributions of D-region electron density are presented, derived from measurements of partial reflections and pulsed ionospheric cross modulation. The measurements were made during sunspot minimum conditions at four different latitudes: 19°S, 35°N, 60°N, and 69°N. Particular attention was given to the study of diurnal changes in the D region. It is concluded that the electron densities in the undisturbed D region show a smooth diurnal change with a maximum near local noon, in the height range covered by the measurements (65 to 90 km). (auth) (UK)

19859 SODIUM IN THE UPPER ATMOSPHERE: METEORIC ORIGIN. Gadsden, M. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Atmos. Terrest. Phys., 30: 151-61(Jan. 1968).

Recent observations of the distribution of atomic sodium showed that the scale height on the topside of the sodium layer can be much smaller than the atmospheric scale height. These observations have been interpreted in terms of release of atomic sodium from dust particles in the upper atmosphere; it is suggested that an alternate explanation may be obtained from consideration of ablation from meteors. (auth) (UK)

19860 OCCURRENCE OF LARGE IONOSPHERIC IRREGULARITIES. Okoye, S. E.; Hewish, A. (Cambridge Univ., Eng.). J. Atmos. Terrest. Phys., 30: 163-7(Jan. 1968).

Extended observations of large-scale ionospheric irregularities were made during 1963 to 64 using a radio interferometer on a baseline of 10 km. The irregularities appear to be similar to those detected by the Faraday fading of satellite transmissions. A pronounced seasonal variation in the occurrence of the irregularities was observed, having a maximum in winter. (auth) (UK)

19861 GEOMAGNETIC STORM AND AURORA OF 25-26 MAY 1967. Smith, R. W.; Webber, N. J. (Univ. of Exeter, Eng.). J. Atmos. Terrest. Phys., 30: 169-74(Jan. 1968).

Measurements are presented of some optical and magnetic features of a class II low latitude auroral event on 25-26 May, 1967. The observations were made at the Norman Lockyer Observatory, Sidmouth (UK) (geographic co-ordinates 50°41'N, 3°13'W), where the total magnetic field depression was at least 730 γ, and visible auroral forms were seen in the magnetic zenith. Photometric observations of [NI] 5200 Å were made throughout the event. Telluric current records showed oscillations exceeding 30 mV/km at 500 MHz during the auroral break-up and also much slower variations of some 120 sec period and more than 40 mV/km amplitude during the recovery phase. (auth) (UK)

19862 LIMITING POLARISATION OF RADIO WAVES OF MEDIUM AND HIGH FREQUENCY REFLECTED FROM THE IONOSPHERE. Bradley, P. A. (Radio and Space Research Station, Slough, Eng.). Proc. Inst. Elec. Eng. (London), 114: 1837-41(Dec. 1967).

Heights of limiting polarisation are evaluated by means of the criterion of Budden for selected models of electron density and collision frequency in the lower ionosphere. For these models, limiting polarisation occurs typically at heights between 50 and 70 km at medium and high frequencies. The electron-collision frequency at these heights is sufficient to influence the polarisation significantly. The dependence of the power available from a linearly polarised receiving aerial on the limiting polarisation of a downcoming skywave signal is investigated. (auth) (UK)

19863 MESOSPHERIC-STRATOSPHERIC COUPLING. Heard, W. C. (Pennsylvania State Univ., University Park). Nature (London), 217: 1038-40(Mar. 16, 1968).

An investigation of mesospheric-stratospheric relationships between electron densities and collision frequencies for stratospheric temperature or constant pressure heights as measured during winter periods of 1964 and 1965 by the wave interaction method of Ferraro and Lee is described. Because of the large variability of temperature, neutral density, electron collision frequency, and electron density during the winter months it was hoped that a coupling of these parameters could be found. No significant relation was found between temperature in the stratosphere and electron density or collision frequency. Significant relationships between these parameters may not exist, or may be obscured by time lags, observational errors, or by the influence of other variables. Previous "successful" comparisons were made during periods of "explosive warmings," and it is possible that there is no significant coupling between electric variables at the mesosphere and middle stratosphere temperatures during ordinary warmings. (UK)

19864 AIRGLOW OBSERVATIONS AND DECAY OF THE IONOSPHERIC EQUATORIAL ANOMALY. King, J. W. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 30: 391-402(Mar. 1968).

Many points of similarity are noted between the movement and morphology of the inter-tropical airglow arcs, described by Barbier and his coworkers, and the crests of the ionospheric equatorial anomaly during both quiet and disturbed conditions, at different epochs of the sunspot cycle and in different seasons. The evidence makes it reasonable to assume that the observed movements of the arcs towards the Equator during the night indicate corresponding movements of the crests of the equatorial anomaly. It is concluded that the crests move towards the magnetic equator at a rate of approximately 1.5°/hr during the period 18.00 to 24.00 L.M.T., and that the rate of movement decreases after midnight and ceases at about 03.00 L.M.T. This movement is the exact reverse of that observed during the development of the equatorial anomaly, when the crests move outwards at a rate of approximately 1.4°/hr until 15.00 L.M.T., when they are furthest from the Equator. (auth) (UK)

19865 INTERPRETATION OF PRE-SUNRISE ELECTRON DENSITIES AND NEGATIVE IONS IN THE D REGION. Sechrist, C. F. Jr. (Univ. of Illinois, Urbana). J. Atmos. Terrest. Phys., 30: 371-89(Mar. 1968).

Pre-sunrise rocket measurements of the electron density in the D region were carried out at Wallops Island, Virginia, on 15 July 1964, 14 June 1965, and 14 June 1966, when the solar zenith angle was near 95°; these rocket measurements were complemented by ground-based, steep-incidence vlf amplitude measurements of the NSS skywave. On 15 July 1964 and 14 June 1965 the rocket measurements revealed the presence of electrons in the D region when the solar zenith angle was near 95°, and the vlf recordings showed absorption commencing at $\chi = 94°$, approximately. During the pre-sunrise period on 14 June 1966 the vlf absorption commenced when the solar zenith angle was near 98°, and a rocket experiment near $\chi = 94°$ revealed an electron density profile almost identical to that obtained on 14 June 1965, the exception being a ledge of ionization between 85 and 90 km. Based on the rocket electron density and vlf measurements, and assumptions of the height distribution of ozone, it is suggested that the vlf amplitude decreases near $\chi = 94°$ and $\chi = 98°$ were caused by the photodetachment of electrons from high-electron-affinity negative ions by solar uv radiation. Also, it is believed that an occasional vlf amplitude decrease commencing near $\chi = 99°$ is caused by the photodetachment of electrons from a low-electron-affinity negative ion by solar visible radiation. (auth) (UK)

19866 GROWTH OF THE D REGION AT SUNRISE. Mechtly, E. A. (Univ. of Illinois, Urbana); Smith, L. G. J. Atmos. Terrest. Phys., 30: 363-9(Mar. 1968).

D-region electron density profiles of high accuracy (±10%), and high resolution (0.1 km), are presented for flights of each of 5 Nike Apache rockets launched at sunrise from Wallops Island, Virginia, at solar zenith angles of 108, 96, 94, 94, and 85°. Orderly increases of electron density between 70 and 80 km are observed as the solar zenith angle decreases from 108 to 94°. At a zenith angle of 94° the observed electron density between 87 and 90 km is larger by a factor of 6 on a morning of high vlf absorption which commenced at 98° compared with mornings of normal vlf absorption which commenced at 94°. At a zenith angle of 85° a "C-layer" of local maximum electron density about 90 cm^{-3} at 68 km, and a decreased electron density at 75 km, are observed. (auth) (UK)

19867 MICROPULSATION ACTIVITY AT LERWICK. Stuart, W. F. (Meteorological Office, Edinburgh). J. Atmos. Terrest. Phys., 30: 337-44(Mar. 1968).

A handscaled analysis of micropulsation activity at Lerwick Observatory was carried out which shows some agreement with previous handscaled work using different equipment. Day and nighttime activity are confirmed to occupy essentially different period ranges, and a correlation of π activity with acceptable auroral zone current models is indicated. High energy particle fluxes are suggested as a source of Pc activity. (auth)

19868 THE DISTRIBUTION OF IRREGULARITIES IN THE ANTARCTIC IONOSPHERE. I. MEAN SEASONAL MAPS AT SUNSPOT MINIMUM. Titheridge, J. E.; Stuart, G. F. (Univ. of Auckland, New Zealand). J. Atmos. Terrest. Phys., 30: 85-98(Jan. 1968).

Fourteen transits of the satellite S-66 were recorded at Scott Base (78°S, 167°E) each day since October 1964. The records are scaled to determine the degree of irregularity of the ionosphere at intervals of 0.2 min throughout each transit. By combining the results from 3000 separate transits the mean degree of irregularity of the Antarctic ionosphere was mapped over a large area, including the geographic, geomagnetic, and dip poles and extending across the auroral zone. Intense field aligned irregularities were observed for 65% of the time in both winter and summer. The area between the geographic and geomagnetic poles was consistently irregular in both seasons. A weaker irregular region extended along the line L = 20 to include the dip pole. There was a slight increase in the density of irregularities at all points in winter, and the percentage fluctuations in electron density were twice as large in winter as in summer. A narrow disturbed region at 170°E in winter coincided with a region of increased f_0F2. The ionosphere was generally smoother away from the poles, and there was no disturbed region associated with the auroral zone. (auth) (UK)

19869 CHARACTERISTICS OF LARGE IONOSPHERIC IRREGULARITIES. Titheridge, J. E. (Univ. of Auckland, New Zealand). J. Atmos. Terrest. Phys., 30: 73-84(Jan. 1968).

The period of the Faraday fading of 20 Mc satellite signals was plotted throughout 521 transits of three different satellites at heights of 200 to 1600 km. From these plots the size and electron content of 2650 separate irregularities were determined. The calculated sizes were spread evenly over the observable range from 10 to 400 km. The irregularities were not field aligned, but were flattened vertically with a mean thickness of 0.4 times the horizontal size. They were more common during the day than at night. The number of irregularities observed at any height was proportional to the electron density at that height, suggesting that the percentage changes in electron density are approximately the same at all heights. These changes were generally between 1 and 10% and were independent of the size of the irregularities. The changes in total content, 0.1 to 10%, were therefore proportional to size. The mean horizontal gradients in total content were independent of the size of the irregularity and of the time of day. (auth) (UK)

19870 THE EFFECT OF WINDS ON THE IONOSPHERIC F2 PEAK. II. Rishbeth, H. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 30: 63-71(Jan. 1968).

An approximate method of calculation (Rishbeth, 1967) was used to investigate further the effects of meridional winds in the neutral air on the ionospheric F2 peak. The wind speeds were taken from new time-varying calculations by Geisler (1967). Over a range of latitudes, the winds produce a morning maximum of peak electron density N_mF2 followed by a rapid afternoon decrease, which does not resemble F2-layer behavior. No seasonal anomaly of N_mF2 was found. The winds can qualitatively account for observed day-to-night changes, of the order of 100 km, in the height h_mF2 of the peak. At night, in the presence of winds, N_mF2 can be maintained at between 10^4 and 10^5 cm^{-3} by a physically reasonable influx (10^7 cm^{-2} sec^{-1}) of ionization from the protonosphere. (auth) (UK)

19871 AURORAL ENHANCEMENT OF ATOMIC NITROGEN. Brown, R. R. (Univ. of California, Berkeley). J. Atmos. Terrest. Phys., 30: 55-61(Jan. 1968).

Calculations were carried out to show the nighttime growth of atomic nitrogen at ~100 km with the incidence of auroral electrons. For typical densities of auroral ionization, judged from riometer observations of cosmic radio noise absorption, the nitrogen concentration rises rapidly to levels in excess of daytime conditions. Atomic emissions from electron impact excitation with the enhanced nitrogen concentration do not, however, compete with those due to recombination processes of ions (N_2^+) from the stable molecular nitrogen reservoir. (auth) (UK)

19872 DAILY RESPONSE OF THE UPPER F REGION TO CHANGES IN UPPER ATMOSPHERIC TEMPERATURE AND GEOMAGNETIC ACTIVITY. Chandra, S.; Krishnamurthy, B. V. (Goddard Space Flight Center, Greenbelt, Md.). J. Atmos. Terrest. Phys., 30: 47-54(Jan. 1968).

The day-to-day variations of the daytime F-region electron density at four representative magnetic dip zones, namely 0 to 5, 25 to 30, 45 to 50, and 65 to 70, were investigated in relation to other geophysical parameters such as the temperature of the neutral atmosphere, the daily sum of the planetary magnetic indices (Σ Kp), and the 10.7 cm solar flux. For this purpose, the plasma frequencies at 1000 km (JFOS) and the critical frequencies (JFOF2) obtained from the Alouette I satellite, and the neutral temperatures derived from the Explorer IX satellite drag data over a six-month period from October 1962 to March 1963 were used. In general, it is found that the day-to-day variations of JFOS and JFOF2 in the daytime follow the corresponding variations of the neutral temperature and Σ Kp. This trend is not evident with 10.7 cm flux. Correlation coefficients obtained between JFOS, JFOF2 vs temperature and vs Σ Kp show a marked latitudinal dependence. Some of the implications of the results obtained are discussed. (auth) (UK)

19873 THE MORPHOLOGY OF THE VHF RADIO AURORA AT SUNSPOT MAXIMUM. IV. THEORY. Unwin, R. S.; Knox, F. B. (PEL Auroral Station, Omakau, New Zealand. Physics and Engineering Lab., Lower Hutt, New Zealand). J. Atmos. Terrest. Phys., 30: 25-46(Jan. 1968).

Calculations were made to determine where in the high-latitude ionosphere the two-stream instability discovered by Farley might occur. General agreement between calculated and observed regions of occurrence, as well as general agreement in other features, is obtained when the discrete types of radio aurora are considered. It is concluded that the diffuse radio aurora is due to the Farley instability, while the discrete types may be due to energetic particle precipitation. (auth) (UK)

19874 AN EXPLANATION OF PHENOMENA OCCURING IN THE HIGH-LATITUDE IONOSPHERE AT CERTAIN UNIVERSAL TIMES. King, J. W.; Kohl, H.; Preece, D. M.; Seabrook, C. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 30: 11-23(Jan. 1968).

Atmospheric winds which are produced at F-layer heights by neutral-atmosphere pressure gradients could cause various phenomena which are observed in the high-latitude ionosphere at certain Universal Times. These effects include the occurrence of maximum critical frequency and layer height near 06.00 U.T. in the Antarctic region, and similar behavior at 20.00 U.T. at high northern latitudes. Various other phenomena at higher middle latitudes may also be associated with the winds. These include secondary maxima of critical frequency near 03.00 L.M.T., phase differences between the diurnal variations of critical frequency at stations having similar magnetic and geographic latitudes but different magnetic declinations, and also the occurrence of sporadic ionization. (auth) (UK)

19875 RAY TRACING IN THE IONOSPHERE AT VLF. I. Walker, A. D. M. (Rhodes Univ., Grahamstown, South Africa). J. Atmos. Terrest. Phys., 30: 403-9(Mar. 1968).

Booker's method of ray tracing in a horizontally stratified magneto-ionic medium is extended to deal with frequencies so low that the effect of heavy positive ions is important. Some rays are traced in a suitable model of the topside ionosphere. (auth) (UK)

19876 RAY TRACING IN THE IONOSPHERE AT VLF. II. Walker, A. D. M. (Rhodes Univ., Grahamstown, South Africa). J. Atmos. Terrest. Phys., 30: 411-21(Mar. 1968).

A simple ray tracing technique is used to discuss some of the properties of subprotonospheric whistlers. The ionosphere is assumed to be horizontally stratified. It is unnecessary to assume a complicated horizontal electron density gradient. (auth) (UK)

19877 TIME OF SUNRISE EFFECT IN THE TOPSIDE IONOSPHERE IN SUMMER. King, J. W.; Eccles, D.; Reed, K. C. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 30: 423-30(Mar. 1968).

It is shown that during midsummer at a latitude where the magnetic dip is 40° the sunrise effects at heights between 400 and 700 km in the topside ionosphere occur near the time of sunrise at 100 km. Sunrise effects at 900 km are noticed half-an-hour later than this. During the sunrise period the plasma temperature increases by about 60% for several hours. (auth) (UK)

19878 RELATIONSHIP BETWEEN 10-cm SOLAR FLUX AND ELECTRON CONCENTRATION IN TOPSIDE IONOSPHERE. King, J. W.; Reed, K. C. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 30: 431-7(Mar. 1968).

It is shown that the electron concentration at heights above the peak of the F2 layer increases by a factor of between 2 and 5 during periods of enhanced 10.7-cm solar flux. The effect is more pronounced at a latitude where the magnetic dip is 30° than above the magnetic equator. There is no obvious accompanying effect in the critical frequency of the F2 layer, and the combined evidence suggests that the entire topside electron distribution is displaced upwards during periods of enhanced solar flux. (auth) (UK)

19879 PEARL-TYPE GEOMAGNETIC OSCILLATIONS. Sen, A. K. (Columbia Univ., New York). J. Atmos. Terrest. Phys., 30: 439-51(Mar. 1968).

It is shown that a sudden commencement of magnetic storm can initiate magneto-acoustic oscillations of the boundary of the magnetosphere in a direction transverse to itself. The characteristic oscillations thus set up will cause a periodic variation of the path length in the outer magnetosphere for the shorter period micropulsations. This will produce a long period modulation of the transmission coefficient for these micropulsations. The result will be the appearance of amplitude modulated signals on the surface of the earth, which are known as "pearl-type" micropulsations. (auth) (UK)

19880 THE ENERGY LOSS FACTOR FOR ELECTRON COLLISIONS IN THE D REGION. King, J. W. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 30: 459-62(Mar. 1968).

Measured values of the quantity $G\nu_{eff}$ (where G is the energy loss factor for electron-molecule collisions and ν_{eff} is the effective collision frequency) obtained for accurately known heights near 85 km by means of wave-interaction experiments were used to derive values of G. The appropriate values of ν_{eff} were obtained from (Thrane, E. V. and Piggott, W. R., J. Atmos. Terrest. Phys., 28: 721(1966)). G was found to be 5.0×10^{-3} on an average, this value being significantly greater than that used in the past by some wave-interaction experimenters in their derivations of collision frequency values. (auth) (UK)

19881 SPORADIC E AND THE F2 LAYER AT MIDDLE LATITUDES. King, J. W.; Pratt, R.; Newman, W. S. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 30: 463-7(Mar. 1968).

Data are presented which show that the diurnal variations of f_0F2 and fE, at middle latitudes in summer during sunspot minimum conditions are frequently very similar. Both variations are anomalous in that maxima occur near 08.00 and 20.00 L.M.T., with a minimum near 14.00 L.M.T. It is suggested that the peculiar diurnal behavior may be partially explained by atmospheric winds. (auth) (UK)

19882 EFFECT OF A TOTAL SOLAR ECLIPSE ON LONG-PATH VLF TRANSMISSION. Kaufmann, P.; Schaal, R. E. (Mackenzie Univ., Sao Paulo, Brazil). J. Atmos. Terrest. Phys., 30: 469-71(Mar. 1968).

The effects of the total solar eclipse of 12 November 1966 on vlf transmissions at 26.1 kHz transmitted from NPM, Hawaii, and received at São Paulo, are described. The eclipse occurred during the sunrise transition period, making data interpretation rather difficult. There was a clear marked change of phase, corresponding to a maximum delay of 12.3 μsec. (auth) (UK)

19883 A CONSIDERATION OF THE EFFECTIVE RECOMBINATION COEFFICIENT IN THE E REGION OF THE IONOSPHERE. Yonezawa, T. (Radio Research Labs., Tokyo). J. Atmos. Terrest. Phys., 30: 473-8(Mar. 1968).

A suggestion is made to interpret at least part of the existing discrepancies concerning the effective recombination coefficient in the E region by assuming that ions in a highly excited vibrational level recombine with electrons much more slowly than those in the ground state or in a low-lying level. (auth) (UK)

19884 ELECTRON COOLING IN THE UPPER ATMOSPHERE. Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.); Degges, T. C. Planet. Space Sci., 16: 125-7(Jan. 1968).

The energy loss rates arising from electron-impact-induced transitions among the fine-structure levels of atomic oxygen are calculated. It is shown that the process is the dominant cooling mechanism for a wide range of electron temperatures throughout the E and F regions of the ionosphere, and it is suggested that the additional cooling may resolve the discrepancies that exist at altitudes between 200 and 300 km between the backscatter data and theoretical predictions. (auth) (UK)

19885 LUNAR TIDES IN NOON ELECTRON DENSITY AT FIXED REAL HEIGHTS IN THE IONOSPHERE OVER PUERTO RICO AND HUANCAYO. Sharma, R. P.; Rastogi, R. G. (Physical Research Lab., Navrangpura, India). J. Atmos. Terrest. Phys., 30: 453-8(Mar. 1968).

Lunar semimonthly oscillations in the electron density at fixed real heights of the ionosphere at noon over Puerto Rico and Huancayo during the periods March 1959 to December 1961 and January 1960 to December 1961, respectively, were computed. The amplitude of the tide, M_2, for both the stations was found to increase monotonically with height during each of the seasons, there being about 50 times enhancement of tidal amplitude from the base to the peak of the F2 region. At any fixed height, the amplitude is largest during November–February and least during May–August. The phase of the tide appears to remain constant with height at Huancayo, but varies considerably with height at Puerto Rico. During any of the seasons the tides at about 180 km above Huancayo and Puerto Rico are almost in the same phase. (auth) (UK)

19886 TEMPORAL VARIATIONS IN Pcl GEOMAGNETIC MICROPULSATIONS. Fraser, B. J. (Univ. of Newcastle, New South Wales). Planet. Space Sci., 16: 111-24(Jan. 1968).

Pcl geomagnetic micropulsation data recorded at Christchurch, New Zealand and Newcastle, N.S.W., were examined for diurnal and stormtime variations in hydromagnetic emissions. The application of hydromagnetic wave packet dispersion theory to hydromagnetic emission propagation path latitude determination shows that: (1) emissions are generated in the $4.5 \lesssim l \lesssim 9.5$ region of the magnetosphere; (2) there is a significant diurnal variation in propagation paths of approximately 2 to 3 R_E; (3) there is a geomagnetic storm-time depression in propagation paths of 1 to 2.5 R_E for moderately severe storms ($K_p \geq 6$), and a recovery rate of approximately 0.5 R_E/day. It is suggested that the diurnal variation in propagation paths may provide a simple explanation for the variation in hydromagnetic emission occurrence with latitude. The magnitude of the diurnal and storm-time variations supports the idea of hydromagnetic emission generation by low energy trapped protons. (auth) (UK)

19887 AURORAE. Krasovskii, V. I. (Inst. of Physics of the Atmosphere, Moscow). Planet. Space Sci., 16: 47-59(Jan. 1968).

Aurorae can be distinctly subdivided into three principal types depending on their excitation agent. The first type is connected with excitation by electrons, the second type with excitation by protons, and the third type with magnetohydrodynamic waves, heating the upper atmosphere. All types may occur together. The first and second types are associated with high-latitude regions. Aurorae of the first type, although with a high dispersion, correlate with geomagnetic disturbances accompanying electrojets in auroral zones. The intensity of aurorae of the second type, on the average, increases with decrease in the K and K_p indices. Hydrogen emission avoids the regions occupied by rayed forms with electron excitation. When intense electron and proton fluxes are injected into the atmosphere, the formation of D_{α} becomes more difficult. Large D_H occur in the case of proton and electron injections of low intensity. The considerable energy of inflation and environment of the magnetosphere is converted into the Earth's atmosphere by magnetohydrodynamic waves. The charged particles which lost their energy escape the magnetosphere into near-Earth space. During rayed forms of the first type, and during aurorae of the third type, a drift of positive ionospheric ions outwards is observed, which is indicative of positive charging of the upper atmosphere in relation to ambient space. This process is caused by the difference of proton and electron fluxes in the region of small pitch angles. In the case of nonsymmetric inflation, the magnetosphere is electrically polarized due to the drift of differently charged particles in different directions. At the same time opposite charges are induced in the ionosphere and electrojets are produced. These currents are generated both at the expense of magnetospheric inflation and at the expense of outward emission of ionospheric ions and electrons. The third type of aurorae seems to be associated with the inflation of the magnetosphere by harder charged particles, predominantly in the region of large pitch angles. In this case depolarization of charges in the magnetosphere occurs, mainly due to ionospheric ions and electrons. During aurorae of the third type in the electron spectrum a component appears in the range of tens of eV which ensures orthohelium excitation. This probably takes place due to the difference of potentials between the northern and southern hemispheres during some oscillatory processes or nonsymmetric circulation of the ionosphere in the geomagnetic field. During rayed forms a considerable packing of injected electron fluxes takes place. In general the density of proton and electron fluxes in the region of intense aurorae is higher than in the solar wind. The increased densities can generate from the effect of electric fields or some oscillatory processes. The negative polarization in the magnetosphere contributes to a change in the pitch angles of differently charged particles, during which proton precipitation is hindered and injection of excess electrons into the atmosphere is accelerated. The energy of the solar wind protons (~1 to 2 keV), as follows from rocket and satellite investigations, is much lower than the solar wind energy estimated by the lag of the commencement of geomagnetic storms with respect to solar flares (~10 keV). Direct investigations of near-Earth space do not seem to yield comprehensive information on the characteristics of the solar wind during intense geomagnetic storms. The parameters of the solar wind do not vary as considerably as the intensity and types of geomagnetic disturbances and aurorae. The causes of such discrepancies have not yet been established conclusively. (auth) (UK)

19888 IONOSPHERIC SCINTILLATIONS AT 136 MHz FROM A SYNCHRONOUS SATELLITE. Aarons, Jules; Whitney, Her-

bert E. (Air Force Cambridge Research Labs., Bedford, Mass.). Planet. Space Sci., 16: 21-8(Jan. 1968).

Scintillation observations at 136 MHz were made using the Early Bird synchronous satellite during the summer of 1965 from two middle latitude sites. The diurnal pattern of the scintillations had the following characteristics: (a) Two maxima were found, one near midday, the other near midnight. (b) The patch of irregularities which produced the midday scintillation moved through the antenna beam within a few minutes to 14 min. (c) The midday scintillations had a high probability of occurrence when $f_0E_s \geq$ 5 MHz. (d) The scintillations observed from 1900 to 0300 local time were of long duration (greater than 30 min). (e) The start and stop time of night scintillations were well correlated at Greenbank, West Virginia, and Sagamore Hill, Massachusetts, (a separation of subionospheric latitude of approximately 4°). (f) 48% of the nighttime scintillations were accompanied by spread F; 25% of the night hours showed spread F. (g) The period of the scintillation (peak to peak time of the individual fluctuation) ranged predominantly from 5 sec to 1 min. The picture that evolves is that summer daytime scintillations during periods of low magnetic activity are probably associated with sporadic-E patches of 300 to 600 km with high critical frequency sporadic-E. Nighttime scintillation is correlated with spread F, geomagnetically controlled, and occurs over a large latitude range in the same time zone. (auth) (UK)

19889 ON THE SOLAR CYCLE VARIATION OF IONOSPHERIC F2 LAYER. Huang, Chun-Ming (Radio Wave Research Labs., Taipei, Taiwan). Chin. J. Phys. (Taiwan), 5: 68-85(Oct. 1967).

The solar cycle variation of foF2 is studied, with emphasis on the limiting of foF2 increase at both extremes of solar activity. Various types of variation of foF2 versus sunspot number can be adequately represented by a third-degree polynomial. A quadratic regression is also fairly good for prediction purpose. The effective sunspot numbers at both extremes of solar activity are defined as a measure of the limiting effect, and their temporal and latitudinal variations are investigated. The limiting effect at high solar activity is explained by the variation of the rate of electron decay, while that at low solar activity is considered to be caused by the upward drift of ionization at equatorial region foilowed by the meridional transport which is predominant during high solar activity. (auth)

19890 ON EXPLAINING THE BEHAVIOR OF THE IONOSPHERIC F REGION. Rishbeth, H. (SRC Radio and Space Research Station, Ditton Park, Eng.). Rev. Geophys., 6: 33-71(Feb. 1968).

The current situation in ionospheric physics regarding the large-scale behavior of the F region is reviewed. A basic physical theory of the F region is summarized and the additional physical processes that are thought to influence F-region behavior are listed. The over-all balance of ionization in the F region is also considered in relation to the flux of ionizing solar radiation. With currently available data, it is barely possible to account for the gross quantity of ionization present. Several phenomena of the F region are reviewed and possible explanations discussed. The phenomena include seasonal and annual variations of the F2 layer, the daily variations of peak electron density (N_mF2) and the height of the peak (h_mF2), the nighttime F layer, and the equatorial F2 layer. Further topics of interest, are dealt with, though in less detail. These include the F2 layer during storms and at high latitudes, conjugate point effects, and the existence of negative ions in the F region. In the conclusion, the preceding discussion is recapitulated by listing the observed effects that are suggested to result from each physical process, and brief comments are made on possible future progress. (auth)

19891 ALFVEN WAVES IN THE SOLAR WIND. Unti, Theodore W. J.; Neugebauer, Marcia (California Inst. of Tech., Pasadena). Phys. Fluids, 11: 563-8(Mar. 1968).

Mariner II plasma and magnetic-field data are examined for explicit examples of low-frequency hydromagnetic waves. From the magnetic-field data, several sinusoidal waveforms are isolated. One of these clearly satisfies the hydromagnetic equations relating the magnetic-field variation to the ion-velocity perturbation for an Alfvén wave. This result is consistent with Barnes' theoretical prediction that only the Alfvén mode is not strongly damped in a plasma of moderate or high β. (auth)

19892 THE 27-DAY PERIOD OF GEOMAGNETIC ACTIVITY IN THE AURORAL ZONES AND THE INACTIVE INTERVALS DURING MAGNETICALLY QUIET DAYS. Jacobs, J. A. (Univ. of Alberta, Edmonton); Wright, C. S. Earth Planet. Sci. Lett., 3: 394-8(Feb. 1968).

The index A_p was used to measure daily geomagnetic activity during 1963. Greatly increased activity of giant micropulsations was noted at approximately 27-day intervals. During the interval of the few days of increased magnetic activity as measured by A_p, a sudden reduction was noted in the UT occurrence of the abrupt changes called psc's and coinciding with the class of night-time activity called N-2. There was also a subsequent maximum 9 days later. Possible explanations for these observations in terms of solar activity and solar wind velocity are considered. (A.G.W.)

19893 INFLUENCE OF SOLAR ACTIVITY ON THE PROBABILITY OF OCCURRENCE OF THE E_s LAYERS AND BOUNDARY FREQUENCIES AT MIDDLE GEOGRAPHIC LATITUDES. Samardjiev, Dimitur. Izv. Geofiz. Inst., Bulg. Akad. Nauk., 10: 59-73(1967). (In Bulgarian).

On the basis of data from three stations located in a middle geographic latitude (Dourbes, Juliusruh, and Moscow) for the period 1957-1964, a study was made of the influence of solar activity on the probability of occurrence of a sporadic E_s layer and its boundary frequencies. It was found that with a decrease in the solar activity there is an increase in total probability of occurrence of a sporadic layer, whereas the probability of occurrence of a layer with frequencies $f_0E_s > 3$ and 5 MHz decreases slightly. It is shown that in order to determine the influence of solar activity on the sporadic layer, the probability of occurrence of an E_s layer is not a suitable characteristic since it does not reflect the ionization condition of the layer. It is more expedient to use the mean values of boundary frequencies as an element which is more closely related to the ionization condition of E_s. A positive relationship was found between the relative number of solar spots and the values of the boundary frequencies of the E_s layer. The decrease of f_0E_s from 1957 to 1964 is about 1.0 MHz (25%) and is slightly greater than the respective decrease of the critical frequencies of the normal E layer. A study was made of the behavior of the boundary frequencies for a constant zenith angle of the Sun ($x = 75°$) in which a seasonal course appears with a very well pronounced double wave, with a maximum in winter and summer and a minimum during the equinoctial months. (ATD)

19894 TIME VARIATION OF ELECTRON PRODUCTION IN D REGION DURING SOLAR CHROMOSPHERIC FLARES. Nestorov, Georgi. Izv. Geofiz. Inst., Bulg. Akad. Nauk., 10: 13-21 (1967). (In Bulgarian).

A complete equation is derived for relative changes in electron production in the D region in its most general form and expressions are obtained for partial cases with medium and weak flares. The behavior of individual members of the equation is analyzed for an effective coefficient of recombination a and it is demonstrated that this coefficient probably increases substantially in the presence of stronger flares. The factor of negative ions, just as the rate of their change, also increases under these conditions. The derived course of relative electron production is close to the form of a burst of solar radio radiation in the centimeter range. In the presence of strong flares ionospheric relaxation greatly increases, especially a few hours before noon. This result indicates the inapplicability of the simple equation of relaxation of the recombination type in the presence of solar chromospheric flares. The resultant time dependence of relative electron production in the D region makes it possible to determine the integral x-ray flux which is the cause of observed ionospheric effects, as well as its variations in time. (ATD)

19895 AUXILIARY IONIZATION AT THE BASE OF THE D REGION DUE TO SOLAR COSMIC RAY PENETRATION. Nestorov, Georgi; Velinov, Petur. Izv. Geofiz. Inst., Bulg. Akad. Nauk., 10: 23-30(1967). (In Bulgarian).

Auxiliary electron production, Δq, due to solar cosmic-ray penetration in the base of the D region is treated quantitatively. Quantitative analysis is carried out in two, mutually independent, ways, the limiting results being in good agreement. The case of May 4, 1960, which is well known from the literature, is taken as an example. The first method is based on auxiliary absorption which is recorded at long waves. The measure of absorption ΔL is the difference between the field of a standard type chromospheric flare (E_1) and the field in the presence of solar cosmic rays (E_2). Quantitative determination of Δq was carried out taking into account balance equations for a quiet and for a disturbed ionosphere. Auxiliary absorption ΔL is based on measured ionospheric parameters. A value of $\Delta q \approx 5 \cdot 10^{-3}$ cm$^{-3} \cdot$ s^{-1} is obtained. In the second method of determination of Δq or $\delta q(h)$ use is made of cosmic-ray data near the location of radio reflection. A value of $\delta q(70km) = \Delta q = 2 \cdot 10^{-3}$ cm$^{-3} \cdot$ s^{-1} is obtained. Values obtained by both methods are in practical agreement. It is clear that auxiliary ionospheric absorption may serve as a quantitative measure with respect to auxiliary cosmic-ray flux. (ATD)

19896 ABSORPTION MEASUREMENT USED IN STUDY OF IONOSPHERE STRUCTURE. Serafimov, Kiril. Izv. Geofiz. Inst., Bulg. Akad. Nauk., 10: 31-42(1967). (In Bulgarian).

A method of analytic-experimental separation of total absorp-

tion into its two basic parts, deflecting and nondeflecting, is considered. This method utilizes measurements of total absorption at two sufficiently separated sections which are reflected from a parabolic portion of the E layer. Under these conditions the deflecting and nondeflecting absorptions prove analytically dependent and may be expressed by measurements through solution of the appropriate system of total absorption. From the known nondeflecting absorption of one frequency, the corresponding nondeflecting absorption may be found for any other reflected frequency and hence the deflecting absorptions may also be found. Nondeflecting absorption may be used to obtain structures not exposed to sounding of part of the ionosphere (D region, intermediate E–F region), and deflecting absorption for finding control points with respect to dependences N(h) which yield to sounding of ionosphere regions. (ATD)

19897 THE APPARENT SKY TEMPERATURES AND TROPOSPHERIC ABSORPTION ON SOLAR RADIATION AT 7 GHz. Matsuura, Oscar T.; Kaufmann, Pierre (Mackenzie Univ., Sao Paulo, Brazil). Icarus, 8: 193-7(Jan. 1968).

In solar radio astronomy, tropospheric absorption effects are usually neglected at wavelengths larger than 3 cm, but important errors can result when flux measurements are performed at larger zenith angles, even in the centimeter–decimeter wavelength range. In this range, the absorption is caused by interaction of the propagating radiation with the magnetic dipole moment of molecular oxygen and the electric dipole moment of water vapor. This note is concerned with tropospheric effects at 7 GHz, on solar radiation, since with the use of higher sensitivity radiometers, even with crystal mixer heads, corrections to the observations become necessary. (W.D.M.)

19898 INTRODUCTION TO SPACE SCIENCE. Hess, Wilmot N. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1965. 933p. $29.75 Hardbound edition, $12.50 Professional edition.

The subject matter of the articles was chosen to cover the spectrum of research areas that have been made available by the artificial satellite. Each chapter was written in such manner as to be self-contained and does not assume prior knowledge of the subject. They are intended to introduce the subject and to convey an understanding of its basic principles with mathematical developments held to that necessary to explain significant points. The bibliography for each chapter was confined to survey articles or major research papers on the topic of the individual article. Topics include the Earth's magnetic field, the Earth's atmosphere, ionosphere, radiation belts, aurorae, meteorology from space, shape of the Earth, the interplanetary medium, boundary of the magnetosphere, cosmic rays, interplanetary dust particles, cosmic chemistry, orbital mechanics, man in space, origin of the solar system, the Sun, the Moon, planetary atmospheres, planetary structure, space astronomy, stellar evolution, extragalactic radio sources, and nucleosynthesis. (W.D.M.)

Low-Temperature Physics

Refer also to abstracts 19199, 20064, and 20097.

19899 (AD–661848) PROCEEDINGS OF THE SYMPOSIUM ON THE PHYSICS OF SUPERCONDUCTING DEVICES, HELD AT THE UNIVERSITY OF VIRGINIA, APRIL 28–29, 1967. (Virginia Univ., Charlottesville. Dept. of Physics). 138p. (CONF-670443). CFSTI.

The purpose of the symposium was to exchange ideas on new applications of superconductors. Computers and high-field magnets were specifically not included in order to limit the size of the meeting. Only 3 or 4 of the papers are concerned directly with the basics and theory of superconductors; most of the 22 papers are concerned with their use in specific devices or equipment, e.g., magnetometers, interference devices, far-infrared detectors, high-Q microwave cavities, gravimeters, noise thermometers, tunnel junctions, switching devices, parametric amplifiers, interference devices and super-inductors. The meeting served to emphasize the strikingly wide range of applications. Devices and techniques using superconductors are making possible new kinds of experiments and are vastly extending the range of sensitivity for measuring various physical quantities. Discussions about fluctuations and noise in superconductors indicated a growing concern with these topics, both from a fundamental point of view and as limitations on devices. (L.M.T.)

19900 (NP–17338) IMPROVED STABILIZED SUPERCONDUCTORS. Research Report No. 291. El Bindari, A.; Bernert, R. (Avco-Everett Research Lab., Everett, Mass.). Mar. 1968. 15p.

A theory of the stable transition of a superconductor between normal and superconducting states is reviewed and data supporting this theory are presented. Data on copper-clad Nb–40% Ti are presented, and the slope for the variation of the critical current with wire diameter is found to be 1.5 for wire diameters between .005 and .05 cm. For copper-clad samples of this material, voltage–current data agree remarkably well with the new theory of stabilization. The importance of the superconducting transitional region is emphasized. (auth)

19901 LOCAL TEMPERATURE-GRADIENT CONTRIBUTION TO FLUX-FLOW VISCOSITY IN SUPERCONDUCTORS. Clem, John R. (Ames Lab., Iowa). Phys. Rev. Lett., 20: 735-8(Apr. 1, 1968). (IS–1772).

A normal-core model of type-II superconductors is used to calculate a contribution to the flux-flow viscosity arising from local temperature gradients in the core vicinity. The flux-flow resistivity versus temperature, according to this model, exhibits a minimum for impure, but not for pure, superconductors. (auth)

19902 RAPID STARTUP OF A ^{3}He–^{4}He DILUTION REFRIGERATOR. Neeper, D. A. Cryogenics, 7: 307-8(Oct. 1967).

The refrigerator described has a startup device such that it can be made operational within 15 minutes of starting the diffusion pump. (UK)

19903 STRESS DEPENDENCE OF THE FREE ENERGY IN TYPE-II SUPERCONDUCTORS. Yamafuji, K.; Irie, F.; Bauer, C. L. (Kyushu Univ., Fukuoka). Phys. Rev. Lett., 20: 658-60 (Mar. 25, 1968).

The complete interaction between internal stress fields and magnetic fluxoids in type-II superconductors is determined from the change of the total Gibbs free energy of the system in the mixed state due to the presence of the stress field. The explicit form of the total free energy is considered in order to appreciate the various contributions to the interaction free energy. Previous notions concerning the relative importance of these contributions are examined. (M.H.R.)

19904 "ELECTRIC FIELDS" IN SUPERCONDUCTORS. Bok, J.; Klein, J. (Ecole Normale Superieure, Paris). Phys. Rev. Lett., 20: 660-2(Mar. 25, 1968).

The first experimental evidence of an electric field in a type-I superconductor in the presence of a quasistatic magnetic field is reported. A capacitive coupling between the voltmeter and the superconductor was established and a dynamic measurement method was employed, where the external magnetic field is modulated instead of the capacitor. The voltage corresponding to the electric field is however canceled by a contact potential. (M.H.R.)

19905 SPIN ECHOES IN LIQUID ^{3}He AND MIXTURES: A PREDICTED NEW EFFECT. Leggett, A. J. (Univ. of Sussex, Eng.); Rice, M. J. Phys. Rev. Lett., 20: 586-9(Mar. 18, 1968).

It is deduced that the "apparent" spin-diffusion coefficient D_{eff} measured by the spin-echo technique should show a maximum as a function of temperature. The effect is estimated to lie in the experimentally attainable range for both pure ^{3}He and dilute mixtures, and should give a direct value of the Fermi-liquid parameter Z_1. (auth)

19906 EVIDENCE FOR A NEW KIND OF ENERGETIC NEUTRAL EXCITATION IN SUPERFLUID HELIUM. Surko, C. M.; Reif, F. (Univ. of California, Berkeley). Phys. Rev. Lett., 20: 582-5(Mar. 18, 1968).

It is shown that neutral excitations which are not photons are produced in superfluid liquid helium in the presence of a ^{210}Po alpha-particle source. At low temperatures these excitations travel through the liquid with negligible scattering. They have sufficient energy to generate positive ions and electrons at the surface of the liquid or at a suitable metal plate immersed in the liquid. (auth)

19907 THE LATTICE SOFTENING IN V_3Si. Vance, E. R.; Finlayson, T. R. (Monash Univ., Victoria, Australia). J. Appl. Phys., 39: 1980-2(Mar. 1968).

Elasticity measurements have been made on several polycrystalline samples which contained various amounts of second phase. The results suggest that the superconducting transition is not directly related to the lattice softening in V_3Si. The relationship between the lattice softening and the martensitic transformation is briefly discussed. For all samples, magnetization vs field characteristics at 4.2°K have been measured to investigate the effect of second phase with respect to the lattice softening of the samples. (auth)

19908 SELF AND MUTUAL INDUCTANCES OF SUPERCONDUCTING STRUCTURES. Sass, A. R.; Stewart, W. C. (Radio Corp. of America, Princeton, N. J.). J. Appl. Phys., 39: 1956-63(Mar. 1968).

The self and mutual inductances of London superconductor structures, of completely generalized geometry, have been derived in terms of London fluxoids. The final expressions for superconducting systems are analogous in form to the inductance expressions found for normal conductors. It is shown, however, that the "fine wire" approximation and the concept of "partial linkages" needed for normal conductors are not necessary when treating superconducting structures. (auth)

19909 ANOMALOUS MAGNETIC BEHAVIOR OF SUPERCONDUCTING VANADIUM AND NIOBIUM. Hecht, E.; Genberg, R. W. (Adelphi Univ., Garden City, N. Y.). J. Appl. Phys., 39: 2159-60 (Mar. 1968).

Torque measurements on bulk cyclindrical specimens of V and Nb show that the magnetization in the superconducting state is not parallel to the applied field. A new technique for determining H_{c1} and H_{c2} is also discussed. (M.O.W.)

19910 CRYOSTAT FOR THERMAL MEASUREMENTS BETWEEN 2 TO 300°K. Bigeleisen, J.; Brooks, F. P.; Ishida, T.; Ribnikar, S. V. (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instrum., 39: 353-6(Mar. 1968). (BNL-11731).

A modification of the Giauque-Johnston cryostat for thermal measurements in the temperature range 2 to 300°K has been designed and constructed. The cryostat utilizes efficient heat switches for cooling. A variable temperature regulated radiation shield between cold wall and the inner sections of the cryostat leads to a working section which can be maintained to a millidegree at any temperature in the working range of the cryostat. The operation and performance of the cryostat are described. (auth)

19911 SUPERCONDUCTIVITY. Pilbrow, J. R. (Monash Univ., Melbourne). Aust. J. Sci., 30: 254-66(Jan. 1968).

An outline is given of some of the important phases of the development of the understanding of superconductivity, with special reference to the influence of the Ginsburg-Landau macroscopic theory and the BCS microscopic theory. It is indicated how superconductors can be classified in terms of the Ginsburg-Landau parameter $\mathcal{N}$. (W.D.M.)

19912 EXISTENCE AND BIFURCATION THEOREMS FOR THE GINZBURG-LANDAU EQUATIONS. Odeh, F. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Math. Phys. (N. Y.), 8: 2351-6(Dec. 1967).

The second-order transition of a superconducting material from normal to superconducting state according to the Ginzburg-Landau theory is rigorously discussed. The bifurcation of a superconducting state is proved for both the Abrikosov mixed state and the case of a film in a parallel magnetic field when the flux or external field is slightly less than critical. The existence of a mixed state for all values of flux below the critical value is also proved. (auth)

19913 PRESSURE MEASUREMENTS IN SUBCRITICAL PURE SUPERFLUID HELIUM FLOW. Corke, Henry E.; Hilderbrandt, Alvin F. (Univ. of Houston, Tex.). Phys. Fluids, 11: 465-9 (Mar. 1968).

The measurement of pressure in He(II) with flowing superfluid superimposed in a stationary normal fluid was undertaken to demonstrate ideal fluid character of the superfluid below critical velocities. Quantitative agreement with Euler's equation with zero curl is shown with slip-flow boundary conditions. Thus, Bernoulli's equation holds for potential flow and superfluid accelerations occur without dissipation. The method of pressure measurement demonstrates that net forces on an object in nonuniform potential flow can be measured. (auth)

19914 INTERACTION OF THE ac JOSEPHSON CURRENT WITH SURFACE PLASMONS. Economou, E. N.; Ngai, K. L. (Univ. of Chicago). Phys. Rev. Lett., 20: 547-50(Mar. 11, 1968).

The possibility of coupling of low-frequency surface plasmons in tunnel junctions to the ac Josephson current is examined. By comparing theory with experiment, some evidence is obtained for the existence of these surface plasmons in tunnel junctions. Further experiments are suggested to establish the kind of coupling responsible for any particular portion of the I-V characteristic. (auth)

19915 SUPERCONDUCTIVITY IN THE Nb_3Al-Mo_3Al SYSTEM. Alekseevskii, N. E.; Kornilov, I. I.; Matveeva, N. M.; Maksimov, Yu. A. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR, 173: 553-6(Mar. 21, 1967). (In Russian).

The temperature dependence of Nb_3Al-Mo_3Al alloy transition into the superconducting state, forming continuous series of solid solutions between Nb_3Al and Mo_3Al was studied. The two compounds correspond to the binary system formed by peritectic Nb_3Al at 2120°C and Mo_3Al at 2150°C. For Nb_3Al, T_c = 18°K, and for Mo_3Al, 0.58°K. The Nb_3Al and Mo_3Al prepared by two melting in suspension in a high-frequency furnace and hot-pressing at 1700°C were thermally treated at 1700°C in helium atmosphere for 4 days. The microstructure and x-ray analyses showed formation of series of β solid solutions with β-tungsten crystal structure. Measurements of critical temperature of transition into the superconducting state was studied by the magnetic method. Graphical data are given on the lattice parameter changes and peritectic reaction of formation. (R.V.J.)

19916 ELECTRODYNAMICS OF TWO-ZONE SUPERCONDUCTORS. THE NEIGHBORHOOD OF THE UPPER CRITICAL FIELD. Moskalenko, V. A. (Inst. of Mathematics and Computing Center, Kishinev, USSR). Dokl. Akad. Nauk SSSR, 173: 546-9(Mar. 21, 1967). (In Russian).

Basic formulas are developed for the electrodynamics of two-zone superconductors suitable for pure and dirty superconductors; detailed studies were made of the upper critical field in pure substances. The Hamiltonian for two-zone superconductors developed by V. A. Moskalenko (Fiz. Metal. Metalloved., 8: 533, (1958)) and supplemented by electron interactions with the impurity are used as a basis to obtain the equations for Green's temperature functions. (R.V.J.)

19917 A STUDY OF STRUCTURAL PHASES IN Nb-Sn SUPERCONDUCTORS. Cabelka, Dusan (Electrical Engineering Inst., Bratislava). Kovove Mater., No. 2, 175-80(1967). (In Czech).

Since previous studies of structure in Nb-Sn superconductors by x-ray, microhardness, and color anodizing methods have not proved completely satisfactory, a method is described employing a Cameca microprobe and electronic microscope, which analyzed phases 3 μ^3 in size and resolved structure from 10 Å. The preparation of samples is described, followed by annealing tests at 700 to 1189 C in a vacuum of 5×10^{-5} mm Hg. Results are illustrated in microphotographs, but no distinctive spectra for superconductor coatings were found. Diffraction of foil samples gave a niobium spectrum and irregular dots that bore no resemblance to structure in an Nb-Sn alloy. Grain surface had been altered in the annealing, since epitaxial growth was evident. (ATD)

19918 RESISTANCE OF A THIN SUPERCONDUCTING THREAD AT NEAR-CRITICAL CURRENTS. Shmidt, V. V. (Baikova Inst. of Metallurgy, USSR). Zh. Eksp. Teor. Fiz., 54: 263-71(Jan. 1968). (In Russian).

The problem of the resistance of a thin superconducting thread with a current in the absence of an external magnetic field is considered by taking temperature fluctuations into account. It is shown that, if fluctuations are not taken into account, a resistance begins to appear at the critical current density j_c, but complete restoration of the resistance is spread out over a broad current range. Fluctuations must be taken into account for currents which are close to the critical value. In this case a resistance begins to appear at currents which are smaller than the critical. The current dependence of the total thread resistance is found for currents close to the critical value. (auth)

19919 OVERHEATING CRITICAL FIELD FOR SUPERCONDUCTORS OF THE FIRST KIND. Galaiko, V. P. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz., 54: 318-23(Jan. 1968). (In Russian).

The stability of the superconducting state of a massive type-I superconductor located in an external magnetic field is investigated on the basis of the Ginzburg-Landau theory of superconductivity. For this purpose the second variation of the thermodynamic potential of the system is calculated as a functional of the parameter of superconducting ordering in the vicinity of the Meissner superconducting state. In an equilibrium state, which is stable with respect to small fluctuations, the potential has a minimum and the second variation is positive. The critical value of the external magnetic field strength for which the second variation of the potential changes sign and the superconducting state becomes unstable is found. (auth)

19920 CRITICAL CURRENT OF COMPOSITE SUPERCONDUCTING CABLE. Shimamoto, Susumu (Electrotechnical Lab., Tokyo). Jap. J. Appl. Phys., 6: 1348-9(Nov. 1967).

The characteristics of two samples of 2 stranded cables which have Nb-Zr and Nb-Ti wire are described. The sample was wound with copper wire of 1-mm diameter and soldered intimately with indium for the purpose of the stabilization. The current-voltage characteristics of the cable at 30 kG are shown. The critical current vs magnetic curves are shown. (M.H.R.)

19921 HYDRODYNAMIC THEORY OF THE RELAXATION OF THE ROTATION OF SUPERFLUID He. Seiden, Joseph (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. A and B, 265: 433-6(Oct. 9, 1967). (In French).

In a previous study an expression for the energy dissipation in superfluid He including vortex lines was derived using the hydrodynamic approximation of Bekarevitch and Khalatnikov. The possibility of applying this expression to the study of the relaxation of the rotation of He was discussed. Two categories of movements are assumed: movements for which $|v_s - v_n|$ is of the order of $|v_s|$ and $|v_n|$ at each instant and in all the He volume. For each of these movements the efficiency of each of the three distinct relaxation mechanism introduced in the previous study is evaluated. (J.S.R.)

19922 SUPERCONDUCTIVITY OF SOME ALLOYS OF THE TUNGSTEN–RHENIUM–CARBON SYSTEM. Neshpor, V. S.; Novikov, V. I.; Noskin, V. A.; Shalyt, S. S. (Inst. of Semiconductors, Leningrad). Zh. Eksp. Teor. Fiz., 54: 25-8(Jan. 1968). (In Russian).

The electric conductivity of some alloys of the W–Re–C system is investigated. It is found that the alloys go over to the superconducting state and that T_c varies from 1°K for pure WC up to 5°K for WC + 6 at. % Re. Further increase of rhenium results in a decrease of T_c. The critical fields and currents are measured at various temperatures. (auth)

19923 SOME FEATURES OF THE TRANSITION DUE TO DESTRUCTION OF SUPERCONDUCTIVITY BY A CURRENT IN SUPERCONDUCTING ALLOYS. Alekseevskii, N. E.; Glasnik, I.; Dubrovin, A. V. (Inst. of Physical Problems, Moscow. Electrotechnical Inst., Bratislava). Zh. Eksp. Teor. Fiz., 54: 84-90 (Jan. 1968). (In Russian).

The effect of the phase composition and structure of superconducting alloys on the nature of their transition during destruction of superconductivity by a current is investigated. Experimental results of a study of current-induced transitions in a $Pb_{0.53}In_{0.47}$ alloy, thermally treated Zr + 4% Nb alloy and commercial Nb–Ti–Zr wire are presented. (auth)

Plasma and Thermonuclear Physics

19924 (NP-17332) FOURTEENTH SIX-MONTHLY PROGRESS REPORT, 1ST JULY-31ST DECEMBER, 1967. (Sydney Univ. (Australia). School of Physics). 11p. (PR-14). Dep.

Brief summaries of research are given on the following topics: plasma sources, JXB fronts, compressional wave studies, large amplitude Alfvén waves, microwave reflection and propagation, and lasers. (M.O.W.)

Confinement and Heating of Plasma

Refer also to abstract 19781.

19925 (CLM-R-85) ECONOMIC GENERATION OF POWER FROM THERMONUCLEAR FUSION. Carruthers, R.; Davenport, P. A.; Mitchell, J. T. D. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Oct. 1967. 33p. Dep. CFSTI. UK 4s. 6d.

Plasma confinement systems are examined as to their potential for satisfying plasma power balance requirements for electrical power generation from the D–T fusion reaction. From this analysis a steady-state toroidal system is taken as a model and engineering parameters are identified defining (i) the form and size of an economic fusion reactor; and (ii) the plasma confinement parameters which must be satisfied. Capital and generation costs for a power station based on this model are estimated and it is shown that the generation costs compare favorably with those from other possible energy sources. A similar study of a D–D reactor indicates that this could provide an economic power source though the confinement parameters are more stringent. These economic studies are used to identify technological problems requiring investigation. (auth) (UK)

19926 (GA-7423) A PULSED COIL SYSTEM FOR GUIDING AND INJECTING PLASMA INTO THE GENERAL ATOMIC TOROIDAL OCTOPOLE. Schupp, Arthur A. Jr.; Ohkawa, Tihiro; Yoshikawa, Masaji (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Sept. 22, 1966. 19p. (CONF-661016-36).

From Symposium on Engineering Problems of Controlled Thermonuclear Research, Gatlinburg, Tenn.

The design and operation of a pulsed coil system for guiding and injecting plasma into the center of a minimum-B magnetic field configuration such as the General Atomic toroidal octopole is discussed. Originally plasma was injected through a system of holes or slots in the side of the device with no coil system to correct the field errors produced by this injection port. Plasma entering the device would interact with the strong vertical magnetic field and then spread around the device near the walls. This produced a high density cloud of cold gas near the injection port which limited the containment time to 30 μsec. A coil system was designed, with none of its elements in the containment volume of the octopole device, that eliminated the main magnetic field from the injection port to the octopole axis during the few microseconds while plasma is injected. A major improvement to the above coil system was made by modifying the system so that a longitudinal guiding field could be produced in the coil system and into the injection channel. The coil was designed in such a way that the amplitude of the guiding field and the field producing the channel could be independently varied. The coil system also produced a slowly varying field (approximately 6 msec) which reduced the main field errors created by the injection port opening. With the final coil system the background pressure of the gas produced by the plasma was reduced from an estimated 10^{-4} torr to approximately 5×10^{-6} torr and the containment increased to a point where it was not completely charge-exchange limited. (auth)

19927 (ORNL-TM-2146) THERMONUCLEAR DIVISION CHRESTOMATHY. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 71p. Dep. CFSTI.

The present status of all experimental efforts of the ORNL thermonuclear group is discussed. (M.O.W.)

19928 (RAE-TR-67279) MAGNETOHYDRODYNAMIC WAVE PROPAGATION FROM A LOCALISED SOURCE INCLUDING HALL EFFECT. Broadbent, E. G. (Royal Aircraft Establishment, Farnborough (England)). Nov. 1967. 66p. Dep.

Lighthill's theorem on magnetohydrodynamic wave propagation from a localized source gives an asymptotic expression for the wave amplitude at large distances from the source, and this theorem is applied to a laboratory plasma. Attention is focused mainly on conditions where the Alfvén speed is large compared with the sound speed, and where the wave frequency is of the same order as the ion cyclotron frequency. These conditions are also typical of certain natural plasmas. The manner in which the wave amplitude depends on the direction of propagation and on the ratio of the wave frequency to the ion cyclotron frequency is examined and illustrated by graphs, which also cover a range of source sizes. An extension is made into a two-fluid theory such that electron inertia and electron source terms can be included, and the effect of finite electrical conductivity is considered. (auth) (UK)

19929 (TID-24228) REPORT OF AD HOC PANEL ON LOW-BETA TOROIDAL PLASMA RESEARCH. (Ad Hoc Panel on Low-Beta Toroidal Plasma Research). Sept. 1967. 121p. Dep. CFSTI.

Theoretical and experimental discussions of a general nature on low-beta toroidal confinement are included. The various specific proposals for toroidal confinement are evaluated. Conclusions and recommendations are included. (M.O.W.)

19930 (UCID-15298) BURNOUT BY NEUTRAL INJECTION IN A TORUS. Lauer, E. J. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 14, 1967. Contract W-7405-eng-48. 10p. Dep. CFSTI.

Mathematical relations are described for the density of hot and cold ions and of H_2 gas molecules. (M.O.W.)

19931 (UCRL-5617-T) ASTRON ELECTRON INJECTION. Christofilos, N. (California Univ., Livermore. Lawrence Radiation Lab.). June 22, 1959. Contract W-7405-eng-48. 26p. Dep. CFSTI.

A new electron injection scheme for the Astron device is described. The relativistic electrons are injected at the top of a mirror field, and thereafter are allowed to slide "down hill" in the valley created by the mirror field. This motion, however, takes place in the presence of dissipative circuits which absorb the axial momentum acquired by the electrons during the "downhill" motion. The momentum of the electrons moving in the mirror field undergoes a transformation whereby azimuthal mechanical momentum is transformed to axial momentum. The latter is absorbed by resistive loops as induction-currents are generated in these loops by the axial motion of the electrons. In this way, the electron bunch arrives at the bottom of the hill with very small axial momentum. About 20% of the electron energy is absorbed in the resistive loops, thus they cannot move up hill unless their energy is enhanced by external means. Each time a new electron bunch is injected it causes a slight energy increase of the already injected electrons. The depth of the potential well required depends on the desired total number of electron bunches which must be injected to establish the E-layer. The required mirror coils are described. This injection arrangement is suitable for very high energy electrons above 20 MeV. For lower energy a focussing arrangement is required to compensate for the axial self-defocussing field. This arrangement is described and a numerical example for 5 MeV electrons is presented. Low energy electrons,

below 5 MeV, are difficult to handle and more complicated focussing arrangements are required. It must be noted that 4 MeV electron energy is the least energy required to establish a plasma under the expected vacuum conditions. (auth)

19932 (UCRL-70655) ALICE EXPERIMENT. Damm, C. C.; Foote, J. H.; Futch, A. H. Jr.; (and others) (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 23, 1968. Contract W-7405-eng-48. 22p. (CONF-671127-3). Dep. CFSTI.

From International Conference on Plasma Confined in Open-Ended Geometry, Gatlinburg, Tenn.

The Alice neutral-injection experiment employs a quadrupole magnetic-well containment field, formed by a coil in the shape of a baseball seam. Plasma densities as high as $5 \times 10^8/cm^3$ have been measured, corresponding to a ratio of $(\omega_{pi}/\omega_{ci})^2 \simeq 0.36$, where ω_{pi} and ω_{ci} are the ion plasma frequency and gyrofrequency respectively. Intermittent plasma oscillations have been observed at densities above $10^8/cm^3$, both at ω_{ci} and at higher frequencies. These oscillations are accompanied by anomalous loss of particles. Bursts of electrons and possibly energetic protons have been detected emerging through the mirror regions. In the presence of these losses the plasma density is limited to a value below that determined by charge exchange. At the highest density reached, the anomalous losses and charge-exchange losses are comparable. Introduction of a small energy spread into the otherwise monoenergetic, 15-keV injected beam was observed to increase the threshold density for onset of the plasma oscillations. In an effort to affect the instability mode or modes observed, and to obtain specific mode identification with theory, experiments designed to further broaden the energy distribution of the trapped protons and other experiments aimed at heating the plasma electrons with microwave radiation are underway. (auth)

19933 (MATT-Trans-52) STUDY OF PLASMA COMPRESSION ON THE "TUMAN" UNIT. Afrosimov, V. V.; Berezin, A. B.; Golant, V. E.; (and others) (Akademiya Nauk SSSR, Moscow. Fiziko-Tekhnicheskii Institut). Translated for Princeton Univ., N. J., from a Russian Report. 25p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

Experiments have been conducted in the adiabatic compression of plasma in a magnetic field of the toroidal type. The preliminary heating of the plasma was done by toroidal discharge. Before compression the concentration of the plasma was 1.2×10^{14} cm^{-3}, and the temperature was 6 to 10 eV. Compression was realized by increasing the magnetic field from 0.5 to 10 kOe in 20 μsec. According to the optical measurements, the "light" radius of the plasma decreases by 3 to 4 times during compression. The concentration of the plasma inside the column increases by 5 to 7 times during compression according to the corpuscular measurement data. As has been shown by experiments on super-high-frequency location of the plasma, one observes a sharp decrease in the plasma concentration in the vicinity of the diaphragm. (auth)

19934 (NP-tr-1617) ANOMALOUS RESISTANCE OF THE PLASMA IN [TOKOMAK] TM-3. Bobrovskii, G. A.; Razumova, K. A.; Shcheglov, D. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated for Culham Lab., Abingdon, Eng., from report IAE-1408. 9p. (CTO-437). Dep. JCL $1.10 fs, $0.80 mf.

A hydrogen discharge with high energy input per particle is investigated. In Tokomak TM-3 it is found that the transverse energy of the plasma determined from the diamagnetic effect, is significantly higher than the electron temperature calculated from the electric conductivity. An analysis of the soft x-ray spectrum confirms the existence of high temperature electrons in the plasma, and the phenomenon is discussed. (auth)

19935 (NP-tr-1619) THE LONGITUDINAL MAGNETIC FIELD IN THE "SIRIUS" RACETRACK STELLARATOR. Biryakov, O. V.; Georgievskii, A. V.; Ziser, V. E.; Kitaevskii, L. Kh.; Tolok, V. T. Translated for Culham Lab., Abingdon, Eng., from At. Energ. (USSR), 23: 134(Aug. 1967). 4p. (CTO-434). Dep. CFSTI. UK. JCL $1.10 fs, $0.80 mf.

Calculations made of the longitudinal magnetic field in the "Sirius" stellarator are briefly summarized. (M.O.W.)

19936 (NP-tr-1621) TOROIDAL CONFIGURATIONS WITH NEGATIVE V" AND SHEAR OF THE MAGNETIC FIELD LINES. Gourdon, C.; Marty, D.; Vuillemin, M. Translated for Culham Lab., Abingdon, Eng., from report CEA-FC-411. 22p. (CTO-441). Dep. JCL $2.60 fs, $1.10 mf.

The comparative investigation of the structure of the magnetic surfaces in the neighborhood of the magnetic axis as a function of l ($l = 2, l = 3, l = 4$) led one to the choice of octupole geometries ($l = 4$) as the only ones providing simultaneously an average magnetic well (of relative depth ~a/R) and considerable shear of the magnetic lines of force. The octupole-based investigation of the influence of the pitch of the helical conductors ($m = 1,3,4,5$) on the value of the rotational transform and the shear ratio is discussed. (M.O.W.)

19937 (NP-tr-1622) EXPERIMENTAL INVESTIGATION OF A TOROIDAL DISCHARGE IN A VARIABLE LONGITUDINAL MAGNETIC FIELD. Ivanov, D. P. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of Russian Thesis. 9p. (CTO-450). Dep. JCL $1.10 fs, $0.80 mf.

Measurements were made of the diffusion coefficient in the Tokomak range of toroidal devices. Brief discussions of the techniques and results are presented. (M.O.W.)

19938 (NP-tr-1624) X-RAY AND OPTICAL MEASUREMENTS ON TOKOMAK TM-3. Shcheglov, D. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated for Culham Lab., Abingdon, Eng., from report IAE-1406. 10p. (CTO-438). Dep. JCL $1.60 fs, $0.80 mf.

Information about the electron distribution function in the Tokomak is obtained by x ray and optical measurements, and various questions arising in this connection are discussed. (auth)

19939 (NP-tr-1632) ALIGNMENT OF THE MAGNETIC SYSTEM IN "SIRIUS." Burchenko, P. Ya.; Vasilenko, B. T.; Volkov, E. D.; Nikolaev, R. M.; Sebko, V. P.; Potapenko, V. A. Translated for Culham Lab., Abingdon, Eng., from At. Energ. (USSR), 23: 135(Aug. 1967). 3p. (CTO-435). Dep. CFSTI. UK. JCL $1.10 fs, $0.80 mf.

The experiments were carried out using a technique based on the repeated passage of a low-energy electron beam. The shape of the magnetic surfaces was investigated on the straight section of the racetrack. (M.O.W.)

19940 PLASMA INJECTION IN A CLOSED MAGNETIC CONFIGURATION. Guillemot, Michel; Veron, Didier (EURATOM-CEA, Fontenay-aux-Roses, France). Compt. Rend., Ser. A and B, 266: 228-9(Jan. 22, 1968). (In French).

The method proposed consists in a temporary modification of the configuration so as to permit the plasma injection parallel to the magnetic lines. The maximum theoretical yield, calculated in one particular case, reaches 60%. (tr-auth)

19941 EXPLOSIVE-DRIVEN MAGNETIC-FIELD COMPRESSION GENERATORS. Shearer, J. W.; Abraham, F. F.; Aplin, C. M.; (and others). (Univ. of California, Livermore). Contract W-7405-eng-48. J. Appl. Phys., 39: 2102-16(Mar. 1968). (UCRL-70572).

An explosive-driven magnetic-field compression device can be used as a source of a large pulse of electrical energy. A number of such systems is described and it is shown how their measured output currents compare with theoretical calculations. Both large-inductance coil geometries and low-inductance coaxial geometries are discussed. Energy losses due to resistive heating, wall compression, electrical breakdown, and gas compression are considered. A numerical calculation procedure for coaxial generators is also described. Coaxial generators were built and tested whose measured output current can be accounted for by calculations of resistive heating and wall compression. Coil geometry generators are measured to be less efficient than calculated. The results also show that further investigations of electrical breakdown and gas compression effects are needed. (auth)

19942 INVESTIGATIONS ON DRIFT OF A PLASMA RING IN A TOROIDAL MAGNETIC FIELD. Junker, J. (Institut fuer Plasmaphysik, GmbH, Garching, Ger.). Phys. Fluids, 11: 646-61(Mar. 1968).

A plasma ring confined by a toroidal magnetic field drifts outward in a radial direction. This drift is caused by an acceleration proportional to an average plasma temperature. Measuring this temperature spectroscopically using the H_β line intensity and the intensity of a continuum interval allows one to calculate the acceleration. Integrating this acceleration twice with respect to time yields the motion of the meridional center of mass of the plasma. The drift motion obtained in this way is compared with the motion directly observed by smear photographs. Within the margins of error of the temperature determination both results give the same drift motion. As a consequence of successive compression and decompression of the plasma ring, magnetohydrodynamic theory shows an oscillating motion of the plasma center in the meridional plane in addition to the gross drift motion. This oscillation can be observed and agrees well in phase but not in amplitude with the theoretical results. The investigations described here were conducted on a toroidal θ-pinch plasma in a tube with a major diameter of 50 cm and a minor diameter of 6 cm. The preionized plasma is compressed and heated by a 4-kJ capacitor bank. The average temperature rises to 7 eV. At a time 2.5 μsec after the onset of the compression, the plasma touches the outer wall of the glass vessel. (auth)

19943 SINGULARITIES OF THE FLUID EQUATIONS AND THEIR RELATION TO ANOMALOUS DIFFUSION. Friedman, Herbert W.; Levi, Enrico (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y.). Phys. Fluids, 11: 678-80(Mar. 1968).

The nonlinear equations governing the diffusion of magnetized plasmas do not admit steady-state solutions when the magnetic field intensity exceeds a critical value. This may explain the onset of instabilities leading to anomalous diffusion. (auth)

19944 ION ENERGY DISTRIBUTIONS IN THE PLASMAS IN THE "TOKAMAK" MACHINES. Afrosimov, V. V.; Petrov, M. P. Zh. Tekh. Fiz., 37: 1955-2006(Nov. 1967). (In Russian).

In order to obtain information concerning the energy distribution of the plasma ions in the T-3 and TM-3 "Tokamak" machines measurements were made of the energy distribution of the hydrogen atoms ejected from the plasmas as a result of charge exchange collisions of plasma ions with low-energy hydrogen atoms produced by electron impact dissociation of hydrogen molecules desorbed from the wall of the chamber. The measurements were undertaken because recent studies of the diamagnetic effect by Artsimovich et al. gave values of the sum $T_e + T_i$ of the electron and ion temperatures exceeding twice the electron temperature T_e as determined from the conductivity of the plasma, thus indicating that either the conductivity measurements of T_e or the diamagnetic effect measurements of $T_e + T_i$ must be in error. When the plasma was stable, the ion distribution was Maxwellian, at least in the central portion of the plasma. Ion temperatures up to 160 eV were found with a plasma density of 3×10^{13} cm^{-3}. When the plasma became unstable there appeared an excess of high-energy ions, indicating the action of some effective ion accelerating process. Electron temperatures were calculated by subtracting the measured ion temperatures from the sum $T_e + T_i$ as determined from the diamagnetic effect, and the ratio T_e/T_i was compared with theoretical values based on the assumption that the ions are heated by electron–ion Coulomb collisions. Agreement was found for plasma densities exceeding 10^{13} cm^{-3}. At lower plasma densities T_e/T_i was lower than the calculated value; from this it is concluded that some process other than electron–ion Coulomb collisions is effective in heating the ions under conditions of low plasma density. (ATD)

Diagnostics of Plasma

Refer also to abstract 19827.

19945 (CLM-R-72) SOME OBSERVATIONS ON THE FLOW OF A TENUOUS PLASMA IN A MAGNETIC FIELD. Atkinson, D. W.; Phillips, J. A. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Dec. 1967. 11p. Dep. CFSTI. UK 1s. 9d.

A coaxial gun is used to inject plasma, particle density ~10^{10} to 10^{11}/cm^3 and velocity ~5×10^7 cm/sec into a longitudinal magnetic field of 780 gauss. Properties of the plasma as it flows down the magnetic field are examined by diamagnetic loops. It is suggested that an apparent loss of transverse energy is not real, but that parts of the plasma jet are accelerated by electric fields produced by the space charge separation of ions and electrons. (auth)

19946 (MATT-520) PROBE TECHNIQUES FOR LOW-DENSITY PLASMAS. Chen, Francis F. (Princeton Univ., N. J. Plasma Physics Lab.). [nd]. Contract AT(30-1)-1238. 16p. (CONF-670104-8). Dep. CFSTI.

From Conference on Physics of Quiescent Plasmas, Frascati, Italy.

The use of electrostatic probes in thermally ionized cesium and potassium plasmas is discussed. The frequency response of the probe and its circuitry are discussed in particular. (M.O.W.)

19947 (NP-17340) MICROWAVE INTERFEROMETRY FOR PLASMAS AND A NEW METHOD FOR DETERMINING COLLISION FREQUENCY. Brand, G. F.; Hooker, C. A. (Sydney Univ. (Australia). School of Physics). Oct. 1967. 24p. (ER-30). Dep.

Electron densities and collision frequencies of a plasma are measured by a microwave interferometer using circularly polarized waves propagating parallel to the magnetic field. The collisionless approximation to the refractive index gives accurate estimates of the average electron density $\langle n \rangle = 1/l \int_0^l n(z)dz$ over several orders of magnitude. The numbers of observable fringes on interferograms taken over a range of magnetic fields gives a new and sensitive method for determining the collision frequency and its dependence on the electron density. Effects of small nonuniformities in the magnetic field are important at fields for which the electron cyclotron frequency ≈ the wave frequency. (auth)

19948 (SC-RR-68-30) MEASUREMENTS WITH A RADIO-FREQUENCY PLASMA IMPEDANCE BRIDGE. Harris, Robert W. (Sandia Corp., Albuquerque, N. Mex.). Feb. 1968. Contract AT(29-1)-789. 19p. Dep. CFSTI.

A low-density plasma impedance bridge has been constructed and calibrated. The active arm of the bridge consists of two radio-frequency coils driven at 500 kc. The presence of plasma in one coil changes the effective impedance of the coil and thus destroys the bridge balance, producing an output signal, the amplitude and phase of which depend on the plasma density and temperature. The bridge was calibrated first by inserting metal rods of various diameters into the sensing coil to produce known changes in the flux threading the coil. The bridge was also used to study plasma pulses from a coaxial rail gun. The results of amplitude and phase measurements indicated plasma electron densities in the range from 1 to 3×10^{10} cm^{-3} and temperatures of about 3000°K. The density determination is in rough agreement with a density determination by another method. (auth)

19949 (NP-tr-1630) INVESTIGATION OF IONIZATION OF HYDROGEN IN TOROIDAL ELECTRIC FIELDS WITH MICROWAVES. Beerwald, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). Translated for Culham Lab., Abingdon, Eng., from report JUL-480-PP. 48p. (CTO-444). Dep. CFSTI. JCL $4.60 fs, $1.64 mf.

Measurements were made on electron multiplication which occurs when a weakly ionized collisional hydrogen plasma is subjected to a sufficiently strong toroidal electric field. To measure electron densities corresponding to neutral particle densities of the order of 10^{16} cm^{-3}, microwave interferometry is suitable. (M.O.W.)

19950 PROPER USE OF ELECTROSTATIC PROBES IN ELECTRODELESS RF PLASMAS. Cantin, A. (Canadian Armament Research and Development Establishment, Quebec); Gagne, R. R. J. IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-16: 279-82(Mar. 1968).

The dc characteristics of electrostatic probes can be modified considerably by the presence of an rf voltage across the junction between the probe and the plasma. Data are presented showing typical examples of such modification of double probe characteristics. It is shown how a correct probe characteristic can be obtained by proper design of the probe and measuring circuit. (auth)

19951 MICROWAVE DIAGNOSTICS OF THE PLASMA SHEATH PRODUCED BY SLOT ANTENNA BREAKDOWN. Mentzoni, M. H.; Row, R. V.; Donohoe, J. (Sylvania Electronic Systems, Waltham, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-16: 277-9(Mar. 1968).

The plasma sheath caused by pulsed rf breakdown in helium outside the aperture of a waveguide radiator has been probed. The highest measurable phase shifts and attenuation changes caused by the plasma were compared with those calculated on the basis of a slab model. The results are consistent with an effective thickness of the plasma sheath of about 1 cm, and electron densities in the active sheath being considerably in excess of the critical value. (auth)

19952 MICROWAVE REFLECTION MEASUREMENTS OF ELECTRON DENSITIES IN ELECTROMAGNETICALLY DRIVEN SHOCK-PRODUCED PLASMAS. Funahashi, Akimasa; Takeda, Susumu (Nagoya Univ., Japan). J. Appl. Phys., 39: 2117-23 (Mar. 1968).

The electron densities from 10^{13} to 10^{17} cm^{-3} in plasmas produced by electromagnetically driven, propagating, or reflected shock waves are measured by a microwave reflection method. The Mach number of the shock waves is varied from 9 to 25 in argon, air, and helium at initial pressures from 0.4 to 2.0 torr. A 35-GHz microwave reflection probe is inserted into a T-type shock tube perpendicular to its axis, or is placed at the tube end parallel with the axis. Despite some perturbation on the gas flow by the inserted probe, surprisingly good agreements are found between the microwave and spectroscopic measurements. The measured electron densities are compared with predicted values calculated from the Rankine–Hugoniot and Saha equations. For Mach numbers higher than 20, the maximum values of the electron densities measured behind the shock fronts agree well with the theoretically predicted values. For low Mach numbers, however, the measured maximum electron densities are lower than the theoretically predicted values. Reasons for the discrepancy between the theoretical and experimental values in low Mach numbers are discussed. In addition, radial and axial density distributions behind the shock fronts are measured for various Mach numbers. (auth)

19953 INFLUENCE OF MULTIPLE REFLECTIONS ON THE ACCURACY OF MICROWAVE-INTERFEROMETER MEASURE-

MENTS OF THE PLASMA ELECTRON DENSITY. Musil, Jindrich; Zacek, Frantisek (Ceskoslovenska Akademie Ved, Prague). Cesk. Cas. Fys., 18: 1-6(1968). (In Czech).

The oscillation character of the dependence of electron density on the mutual position of the receiving antenna and the axis of the plasma cylinder is discussed in two cases: (i) the diameter D of the plasma cylinder is much larger than the wave length λ; (ii) D ≈ λ. In the first case the calculations are performed on the basis of the plane slab approximation of plasma, in the second case on the basis of the scattering of the incident plane wave by the plasma. (auth)

19954 MEASUREMENT OF THE MEAN ELECTRON DENSITY IN A PLASMA CYLINDER. Musil, Jindrich (Ceskoslovenska Akademie Ved, Prague). Cesk. Cas. Fys., 18: 7-10 (1968). (In Czech).

The use of microwave focused beams in measuring the mean electron density N_{mean} in a plasma cylinder is investigated. The criterion for the focused beam width, ensuring the correct measuring of N_{mean} is derived. (auth)

19955 ELECTRON TEMPERATURES AND DENSITIES FROM TRANSIENT HELIUM-LIKE ION LINE EMISSION. Kunze, H.-J.; Gabriel, A. H.; Griem, H. R. (Univ. of Maryland, College Park). Phys. Fluids, 11: 662-8(Mar. 1968).

Measurement of plasma electron temperature is based upon the observation of the decay rate, through ionization, of lines from helium-like ions. Ionization from the ground state is supplemented at higher densities by stepwise ionization through the triplet metastable levels. In an experiment on C v ions in a 15-kJ theta-pinch plasma, this method gives a temperature of 230 eV ±18%, compared with 240 eV measured by the Thomson scattering of laser light. In addition, measurement of the intensity ratio of resonance to intercombination lines in C v as a function of density gives the rate for triplet-singlet transfer collisions, together with the ratio of singlet to triplet excitation, thereby yielding the high-density corrections for the above ionization rate. With this theory, measurements of the intensity ratio can now be used for the determination of electron density in the range 2×10^{14} to 10^{19} cm^{-3}, by selecting the appropriate helium-like ion from B(IV) to Ne(IX), with accuracies of the order 30%. An alternative method for measuring the electron temperature from the absolute intensity of the 2^3S-2^3P multiplet of helium-like ions, based upon the above model together with the Seaton semiempirical formula for the singlet excitation, gave a value of 265 eV ±25% when the temperature measured by scattering was 210 eV. (auth)

19956 COMPARISON OF A MODIFIED-LANGMUIR-PROBE ANALYSIS WITH COMPUTER SOLUTIONS OF ELECTROSTATIC PROBES. Scharfman, W. E. (Stanford Research Inst., Menlo Park, Calif.). Phys. Fluids, 11: 689-91(Mar. 1968).

A quantitative comparison is made between numerical solutions for the current to a free-molecular electrostatic probe and a modified Langmuir analysis. The maximum difference is about 60% over a range of r_p/λ_D from 1 to 10,000. (auth)

19957 DETERMINATION OF THE SPATIAL DISTRIBUTION OF THE EFFECTIVE ELECTRON COLLISION FREQUENCY IN A PLASMA BY MEANS OF MICROWAVE TECHNIQUES. Dnestrovskii, Yu. N.; Kostomarov, D. P. (Moscow State Univ.). Zh. Tekh. Fiz., 37: 2095-7(Nov. 1967). (In Russian).

The electron collision frequency in a plasma was measured with the aid of microwave absorption and reflection for two geometrically differing cases. In the first case the plasma occupies the region x > 0 (x, y, and z are rectangular Cartesian coordinates) and its density is a monotonic function of x only and vanishes for x = 0. Plane monochromatic electromagnetic waves incident normally onto the plasma surface penetrate a certain distance into the plasma and are reflected back out. Equations are written for the phase difference between, and the ratio of the intensities of, the incident and reflected waves. The authors have previously shown how the plasma density can be derived from the phase shift. When the density is known, the equation for the intensity ratio becomes an integral equation for the collision frequency and can be solved numerically by methods discussed in the references cited above. In the presence of a longitudinal magnetic field the integral equation for the collision frequency can be reduced to an Abel integral equation, the solution of which is given. In the second case the plasma is assumed to occupy a cylindrical region. An equation is written for the attenuation of a microwave beam traversing the plasma for the case when the electric vector of the waves is parallel to the external magnetic field and the frequency of the waves is much higher than the Langmuir frequency and the electron collision frequency. (ATD)

19958 TRANSIENT PROCESSES IN A POSITIVE COLUMN PLASMA FOLLOWING CHANGE OF THE DISCHARGE CURRENT. Gladshtein, L. S.; Zastenker, G. N.; Ryzhkina, T. E. Zh. Tekh. Fiz., 37: 2053-60(Nov. 1967). (In Russian).

The time dependence of the electron density was investigated in the 120-cm-long positive column of a hot cathode helium arc burning in a 3-cm-diameter glass tube containing helium at 0.3 mm Hg, following a sudden decrease of the discharge current. A microwave method, calibrated with probe measurements under steady conditions, was employed to measure the instantaneous electron concentrations, which ranged between 10^9 and 10^{11} cm^{-3}. With the arc burning steadily, the current was suddenly (within 1 to 3 μsec) increased by a factor of 20, held at the increased value for a time T ranging from a few microseconds to a few tens of milliseconds, and suddenly decreased to the initial steady-state value, after which the electron density n was recorded as a function of the time t elapsed after the return of the current to its initial value. The shapes of the n versus t curves varied considerably, depending on the values of I and T. When I was greater than 10 and T exceeded a few hundred microseconds, n was not even a monotonic function of t: under these conditions n would drop rapidly to a minimum, which it reached within a few microseconds, rise to a maximum which it reached after a few tens of microseconds and where its value could be greater (and was sometimes much greater) than its value at t = 0, and finally decreased monotonically toward its equilibrium value for the reduced arc current with a time constant of some tens or hundreds of microseconds. The behavior of the n versus t curves is discussed at some length. Numerical solutions to electron concentration and temperature balance equations for diffusion conditions, similar to the equations given by B. L. Granovskii (J. Phys., USSR, 3: No. 3, 195(1940)) but supplemented to include secondary effects, were found to be in good agreement with the experimental curves. It is concluded that the nonmonotonic time dependence of n is due mainly to the effects of ionizing collisions between metastable atoms, the concentration of which decreases less rapidly than does the electron temperature. (ATD)

19959 INTRODUCTION A LA SPECTROSCOPIE DES PLASMAS. (Introduction to the Spectroscopy of Plasmas). Pecker-Wimel, Charlotte. Cours et Documents de Mathematiques et de Physique. New York, Gordon and Breach Science Publishers, Inc., 1967. 165p. $9.50 Cloth, $5.00 Paper.

The formation of the line spectrum and the continuous spectrum are studied. Their intensities and the variation of the intensity with the wave length are calculated. The techniques thus obtained are applied to spectroscopic diagnostics, with a review of the most commonly used methods. Spectroscopic data are then applied to the study of lasers. (tr-auth)

Kinetics of Plasma

Refer also to abstracts 19756 and 19854.

19960 (CLM-R-83) GRAVITATIONAL AND DRIFT WAVES IN A PERIODIC SLAB. Rohlena, K.; Jukes, J. D. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Jan. 1968. 13p. Dep. CFSTI. UK 1s. 9d.

The low-frequency electrostatic drift-acoustic mode and the gravitational flute mode in a periodic gravitational field in a collisionless plasma are examined. As a model, a one-dimensional plasma slab with straight field lines, a small density gradient, and a perpendicular gravity periodic along the field lines is considered. Only the long-wavelength nonlocalized waves are investigated. The periodicity along the field lines causes the modes to combine producing unstable hybrid modes or standing waves. The energy transfer between the resonant electrons and the waves is also examined. (auth) (UK)

19961 (IAE-1400) VZAIMODEISTVIE IONNOGO POTOKA S PLAZMOI MISHENI PRI PEREZARYADKE. (Interaction Between Ion Flux and Target Plasma During Charge Exchange). Kartashev, K. B.; Pistunovich, V. I.; Filimonova, E. A. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1967. 20p. (In Russian). Dep.

The interaction between a homogeneous plasma in the absence of a magnetic field and an ion flux in which the ion temperatures differ in the transverse $T_\perp$ and longitudinal $T_\parallel$ directions with respect to the directional velocity $\vec{u}$ of ions is considered. The effect of the temperature anisotropy of the ion flux on the stability of oblique waves in plasma is elucidated and a comparison with the previously considered cases of isotropic distribution is presented. (JPRS)

19962 (IPPCZ-91) REPORT ON THE INTERNATIONAL SYMPOSIUM ON BEAM-PLASMA INTERACTIONS, PRAGUE, SEPTEMBER 4 TO 6, 1967. (Ceskoslovenska Akademie Ved, Prague. Ustav Fyziky Plazmatu). Oct. 1967. 70p. (CONF-670959). Dep.

Summaries are given of the 28 papers presented. These deal with various aspects of beam–plasma interactions. (M.O.W.)

19963 (JINR–P9–3689) VLIYANIE ION–IONNYKH STOLKNOVENII NA NELINEINOE VZAIMODEISTVIE LENGMYUROVSKIKH VOLN V PLAZME. (The Effect of Ion–Ion Collisions on the Non-Linear Langmuir Wave Interaction in Plasma). Makhan'kov, V. G.; Shchinov, B. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 17p. (In Russian). Dep.

The effect of the ion–ion collisions on the nonlinear Langmuir wave interaction in nonisothermal ($T_e \gg T_i$) entirely ionized plasma has been considered. It is shown that at definite plasma parameters the sequential transformation can essentially change the nature of the nonlinear spectral energy transformation even for not very intensive Langmuir oscillations. (auth)

19964 (JINR–P9–3690) K NELINEINOI TEORII GIDRODINAMICHESKOI PUCHKOVOI NEUSTOICHIVOSTI. II. (On the Non-Linear Theory of a Hydrodynamic Beam Instability. II). Makhan'kov, V. G.; Shchinov, B. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 8p. (In Russian). Dep.

The effect of the nonlinear interaction of harmonic on the quasi-linear relaxation of an aperiodic beam instability is estimated. (auth)

19965 (NP–17339) THE PROPAGATION OF TRANSVERSE ELECTROMAGNETIC WAVES NEAR TO ELECTRON CYCLOTRON RESONANCE IN A MAGNETISED LABORATORY PLASMA. Brand, G. F.; Hooker, C. A. (Sydney Univ. (Australia). School of Physics). June 1967. 9p. (ER–29). Dep.

Experimental observations of the propagation of circularly polarized waves in a plasma parallel to the magnetic field are described. A new method for determining the collision frequency and finding its dependence on the electron density is presented. (auth)

19966 (NP–17341) PROPAGATION OF CIRCULARLY POLARISED WAVES IN A MAGNETISED LABORATORY PLASMA. Brand, G. F.; Hooker, C. A. (Sydney Univ. (Australia). School of Physics). Oct. 1967. 16p. (ER–31). Dep.

The propagation of circularly polarized microwaves parallel to the magnetic field is studied in a laboratory plasma. It is shown that Appleton's equation gives an adequate account of the observations. (auth)

19967 (NP–17342) INTERFERENCE OF CHARACTERISTIC WAVES IN PLASMAS. Brand, G. F.; Hooker, C. A. (Sydney Univ. (Australia). School of Physics). Nov. 1967. 14p. (ER–33). Dep.

The interference between the two characteristic waves in a magnetized plasma has been studied for propagation both parallel and perpendicular to the magnetic field. A new microwave interferometer which has been used to measure electron densities is described. Besides having a simpler construction, it is more sensitive than existing interferometers in certain situations. (auth)

19968 (NP–17343) REFRACTION OF MICROWAVES OBLIQUELY INCIDENT ON A PLASMA SLAB. Brand, G. F.; Hooker, C. A. (Sydney Univ. (Australia). School of Physics). Nov. 1967. 13p. (ER–34). Dep.

A preliminary experiment has been conducted on the refraction of microwaves which are incident at an arbitrary angle on a plane, parallel-sided slab of magnetized plasma. The main features of the experimental results are adequately described when Appleton's equations, for propagation at an angle to the magnetic field, are applied to a simple plasma model. (auth)

19969 (NP–17346) NONLINEAR EFFECTS IN THE PROPAGATION OF LARGE AMPLITUDE ALFVEN WAVES IN A LABORATORY PLASMA. Cross, R. C.; Watson-Munro, C. N. (Sydney Univ. (Australia). School of Physics). Dec. 1967. 24p. (ER–27). Dep.

In a cylindrical hydrogenous laboratory plasma source of diameter 21 cm and length 170 cm, the propagation of Alfvén torsional waves of azimuthal wave field b_θ propagating parallel to a steady magnetic field B_0 in the z direction was studied. The perturbation ratio b_θ/B_0 was increased to values as high as 2.6 and it was found that: (a) As the perturbation ratio is increased the wave rapidly steepens into a shock wave, but at perturbation ratios in excess of 1.2 there is no further reduction in the rise time of the leading edge. (b) The Alfvén Mach Number shows a marked reduction in rate of increase at this perturbation ratio. (c) The attenuation of the wave increases rapidly at this perturbation ratio. (d) Evidence was obtained of the attenuation energy being expended in particle heating and in the development of a higher-frequency magnetoacoustic wave traveling radially outwards in the plasma. (auth)

19970 (NP–17347) MAGNETOHYDRODYNAMIC WAVE MODES BEHIND NORMAL IONIZING SHOCK WAVES. Cross, R. C.; Gross, R. A.; James, B. W.; Watson-Munro, C. N. (Sydney Univ. (Australia). School of Physics). Dec. 1967. 10p. (ER–35). Dep.

The distribution of current loops that develop behind strong ionizing shock waves in a coaxial electromagnetic tube has been studied experimentally and found to be similar to modes excited by two dimensional magnetohydrodynamic waves. (auth)

19971 (NP–17361) SOME NONLINEAR EFFECTS IN ELECTRON CYCLOTRON RESONANCE DISCHARGES. Rijnhuizen Report 67–40. Schrader, W. J. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Oct. 1967. 79p. Dep.

Nonlinear effects near cyclotron resonance in the interaction of standing electromagnetic waves with electrons of a magnetized plasma are studied theoretically and two experiments in which these effects occur are described. The effects are radio-frequency confinement, the influence of relativistic mass variations, and that of velocities parallel to the constant magnetic field. A single particle approach has been used and the experimental work has been done at such low pressures that collective effects are unimportant. A treatment is given of the motion of an electron in a magnetic field $\vec{B}_0$ and an electromagnetic standing wave with polarization perpendicular to $\vec{B}_0$. Variations of the wave fields in the direction perpendicular to $\vec{B}_0$ as well as collisions have been neglected. The treatment of the rf confining force embodies a comparison with the force caused by a gradient of the constant magnetic field. The influence of relativistic mass variations has first been studied with neglect of the parallel motion, and assuming zero thermal velocity. Both the shift of the resonance and the maximum energy are approximately proportional to $(E/\omega)^{\frac{1}{2}}$ where E is the electric field of the wave and ω its frequency. Detailed calculations of oscillation energy and beating frequency between electron motion and electric field are also given for many values of electric and magnetic field; here both analog and digital techniques have been used. Finally, a treatment of the complete three-dimensional motion with an application to energy gain during a reflection by the electromagnetic field along the constant magnetic field is given. The experiments have been done at a frequency of 3.4 GHz with cylindrical cavities, excited in the TE_{111} mode, in a constant uniform axial magnetic field of about 1.3 kG. In one experiment cyclotron resonance breakdown at low pressure in a vacuum cavity has been studied at about 0.3 milliwatt of microwave power. As was also found by other authors using a slightly different apparatus, the minimum breakdown power below a certain pressure does not increase with decreasing pressure but remains constant. This behavior is caused by reduction of parallel diffusion which in this case is counteracted by the rf confining force. The optimum value of the magnetic field for breakdown exhibits an upward shift; the magnitude of this shift agrees with the calculated relativistic effect. In the other experimental chapter a discharge is described which also occurs at low pressure, but at higher power (30 to 300 watt) and at a value of the magnetic field a few percent below resonance. The discharge is maintained by a special kind of multipacting which occurs against the metal end walls of the cavity, where the electric field is zero. Secondary electrons from the wall enter into the electromagnetic field a short distance, gain energy there, and are then reflected with sufficient energy to in turn liberate secondaries. This problem has also been studied and calculated with the approach mentioned above, and there is good agreement between calculations and experiment. (auth)

19972 (UCID–15295) NEUTRAL INJECTION IN THE SUPERCONDUCTING LEVITRON. Lauer, E. J. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 28, 1968. Contract W-7405-eng-48. 8p. Dep. CFSTI.

Neutral injection making use of the gas ionization products as a target plasma has been reexamined. The main processes considered are ionization of gas (of density n_0) by electrons to form H_2^+ ions which are quickly dissociated to form cold H^+ ions (density n_c), loss of n_c due to anomalous diffusion with a mean containment time τ_c, trapping of hot protons (density n_h) by charge exchange with n_c and by ionizing collisions with n_h and loss of n_h by charge exchange with n_o and by anomalous diffusion with a mean time τ_h. The density of electrons is set equal to the density of positive ions. A steady state function exists for τ_c vs n_o (with constant τ_h/τ_c) independent of n_h and n_c. The maximum value of the steady state τ_{co} varies inversely as IL/V where I is the current of energetic H^0, L is the beam path length through the plasma and V is the plasma volume. If τ_c in an experiment is greater than the maxi-

mum value of τ_c on the above steady-state curve, then burnout proceeds until there is exponentiation of n_h independent of n_c; if τ_c is less than the maximum value on the steady state curve, then n_o decreases to the steady state value. In this case n_h and n_c are proportional to I_o the number of new H_2^+ molecules per second entering the plasma. (auth)

19973 (MATT-Trans-51) CORRELATION STUDY OF A PENNING DISCHARGE. Berezin, A. B.; Bulyginskii, D. G.; Vil'Dzhyunas, M. I.; Rodichkin, V. A. (Akademiya Nauk SSSR, Moscow. Fiziko-Tekhnicheskii Institut). Translated for Princeton Univ., N. J., from a Russian Report. 22p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

The spectrum of the oscillations of fluctuations of electric fields in a Penning discharge plasma is obtained, and its relationship to the field distribution in chutes provided for in the theory of drift gradient instability X_0 is established. In addition, the coefficient of turbulent diffusion is obtained for this discharge with the help of the correlation function. The experimental material indicates that the correlation analysis is a fruitful method of investigation of both the macroscopic characteristics of discharge and special features of it connected with the specific form of instability of the plasma in crossed fields. (auth)

19974 (NP-tr-1623) ELECTRICAL CONDUCTIVITY OF A PLASMA IN A STRONG MAGNETIC FIELD. Kadomtsev, B. B.; Pogutse, O. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated for Culham Lab., Abingdon, Eng., from report IAE-1416. 15p. (CTO-428). Dep. JCL $1.60 fs, $0.80 mf.

It is shown that in a strong magnetic field, when the cyclotron frequency of the electrons is greater than their Langmuir frequency, on passing a longitudinal current with directed velocity $u = j/en_0$ which is smaller than the thermal velocity $v_e = \sqrt{T_e/m_e}$, the observed anomalous resistance, in the strictest sense of the term, is small; the conductivity decreases only by a value of the order of $\delta\sigma - \sigma\, u/v_e$. However, in the presence of sufficiently long-lived accelerated electrons an effect might be observed which has all the outward symptoms of an anomalous resistivity. Because of their interaction with the oscillations due to the anomalous Doppler effect, the runaway electrons take on a largely isotropic velocity distribution and may make a significant contribution to the plasma pressure. The "temperature" $T_0 = p/n_0$ determined from the pressure p, may then be considerably higher than the temperature T_e of the main electrons. Correspondingly the classical conductivity, calculated from T_0, will then be higher than the true conductivity. The possibility that an effect of this type is being observed in the Tokomak toroidal systems cannot be excluded. A direct answer might be obtained from x-ray measurements, which might indicate a presence of runaway electrons. (auth)

19975 METHOD OF RESOLUTION OF THE BOLTZMANN EQUATION OF AN IMPERFECT INHOMOGENEOUS LORENTZIAN PLASMA. Hubert, Daniel; Jancel, Raymond (Institut Henri Poincare, Paris). Compt. Rend., Ser. A and B, 266: 222-5 (Jan. 22, 1968). (In French).

By the use of the method of resolution of the Boltzmann equation studied previously, the electron distribution function of an imperfect homogeneous or inhomogeneous Lorentzian plasma exposed to the action of an oscillating electric field was calculated. The results obtained were applied to the calculation of the temperature and the electron current in the homogeneous case. (tr-auth)

19976 MULTIPLE ECHOES OF LONGITUDINAL WAVES IN A PLASMA. Coste, Jean (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. A and B, 266: 226-7(Jan. 22, 1968). (In French).

The plasma is treated as a system of free particles exposed to two successive pulses of the electric field. By use of an exact solution of the evolution equation, it is shown that if the interval of time between the two pulses is very large, a series of echoes of comparable amplitudes appear. (tr-auth)

19977 OSCILLATION EXCITATION IN A DENSE MAGNETOACTIVE PLASMA BY MEANS OF A BEAM OF PHASED OSCILLATORS. Gorbatenko, M. F.; Stepanov, K. N. Zh. Tekh. Fiz., 37: 1768-73(Oct. 1967). (In Russian).

The stability of a beam of phased oscillators (electrons, which in the absence of oscillations have identical phases in the Larmor orbit) during its passage through dense plasma along the internal magnetic field is established. It is shown that in the absence of plasma the beam oscillations are established. In the presence of plasma, in which the collision frequency is high, the oscillator beam excites oscillations with a frequency the multiple of the gyrofrequency of the particles of the beam. (tr-auth)

19978 VISCOUS EFFECTS IN THE LIQUID CONDUCTOR MODEL OF HARD-CORE PINCH. Murty, G. S. Proc. Indian Acad. Sci., Sect. A, 63: 145-65(1966).

The influence of viscous forces on the instability of liquid conductor model of hard-core pinch is investigated theoretically. It is shown that these forces decrease considerably the growth rate of instability in the experiments of Lehnert and Sjogren. It is suggested that as a result of viscous forces, the time scale of instability, if any, is so large that instabilities cannot be obtained in these experiments when the inner and outer currents are parallel. (Indian Sci. Abstr.)

19979 NOTE ON THE CALCULATION OF THE DIELECTRIC FUNCTION FOR A HOMOGENEOUS PLASMA. Dasgupta, B.; Dasgupta, P. Physica, 32: 878-84(1966).

Method of calculating the dielectric function for a homogeneous plasma using the fluctuation-dissipation theorem is discussed. This method dispenses with the use of any kinetic equation in contrast to the usual methods. Calculations using first the "noninteracting dressed" particle picture and second the expression for the density correlation function obtained by Balescu, are shown to lead to the same dielectric function as usually obtained from the Vlasov equation. (Indian Sci. Abstr.)

19980 STUDIES OF THE NITROGEN AFTERGLOW. I. SURFACE CATALYTIC EFFICIENCY AND DIFFUSION-CONTROLLED DECAY OF ATOMIC NITROGEN. Lund, R. E.; Oskam, H. J. (Univ. of Minnesota, Minneapolis). Contract AF19(628)-4794. J. Chem. Phys., 48: 109-15(Jan. 1, 1968).

The temporal behavior of the afterglow light intensity in decaying nitrogen plasmas, as well as that of the number density of N^+, N_2^+, N_3^+, and N_4^+ ions, was studied in the pressure range of about 0.1 to 1.7 torr. The analysis of the light intensity decay curves resulted in a method of measuring the surface catalytic efficiency γ_N for the recombination of nitrogen atoms at the plasma boundary. The simultaneous identification of the ions present in the plasma by means of a quadrupole mass spectrometer ensures that the data relate to pure nitrogen as well as to extremely clean surfaces. The values obtained for γ_N of molybdenum sputtered on a glass surface decreased with pressure from a value of 0.22 at 0.09 torr to 0.04 at 1.35 torr. The studies also showed that part of the afterglow light emission is due to collisions between metastable nitrogen molecules produced in the afterglow by the atomic volume recombination process. (auth)

19981 GENERALIZED SAHA EQUATION FOR NONEQUILIBRIUM TWO-TEMPERATURE PLASMAS. Monti, R.; Napolitano, L. G. (Naples Univ.). pp 517-37 of Combustion and Propulsion. Sixth AGARD Colloquium, Cannes, France, Mar. 16-20, 1964. DeGroff, H. M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

See AGARDograph-81.

A thermodynamic analysis of a ternary plasma (composed of one species of atoms, one species of ions and electrons) is presented and the components of the mixture are considered ideal gases. The state equations of the mixture, considered as thermodynamic system with four degrees of freedom, are written therefrom obtaining the explicit expressions of the affinities (Ai) for the rate processes (i.e., ionization, A_1 and thermalization A_2). The usual form of the Saha equations is recovered when one lets $A_1 = A_2 = 0$ (conditions of "full" equilibrium). The generalized form of the Saha's equation is obtained when one lets only $A_1 = 0$, thus obtaining, upon the acceptable hypothesis of thermodynamic stability, an explicit expression relating the degree of ionization (α) to the three remaining state parameters of the mixture. As an application of this theory the electrical conductivity has been calculated under a number of suitable simplifying hypotheses, as a function of the plasma pressure and temperatures. The correlation of the available experimental results appears to be improved with respect to other more simplified theories. (auth)

19982 TRANSLATIONAL ENERGY DISTRIBUTION OF ELECTRONS AND POSITIVE IONS IN THE PLASMA OF MICROWAVE AND HIGH-FREQUENCY DISCHARGES OF He, Ne, AND Ar. Franklin, J. L.; Studniarz, Stanley A.; Ghosh, P. K. (Rice Univ., Houston, Tex.). Contract Nonr-3623(00). J. Appl. Phys., 39: 2052-61(Mar. 1968). (RICE-2-P).

The mean electron energy, mean positive-ion energy, and sheath potentials in the plasma of microwave discharges were measured by extracting the positive ions and electrons through a small hole in a metal probe and subjecting the effused particles to a retarding electric field. The electron and positive-ion translational energy distribution fitted the Maxwellian distribution function. The mean electron energy was independent of the input power to the cavity and position of visible plasma sampled along the axis of the discharge tube. The electron field in the sheath in front of the probe orifice was mapped and approximate values of the sheath thickness are given. The variations of the sheath potential and electron density with pressure and power

input and sheath potential profiles along the axis of the discharge tube are given. (auth)

19983 EXISTENCE OF TWO TYPES OF ELECTRON-PLASMA-OSCILLATION RESONANT MODES AS A FUNCTION OF CHANGES IN INITIAL ELECTRON DISTRIBUTIONS AND TEMPERATURE. Farrow, L. A. (Bell Telephone Labs., Inc., Whippany, N. J.). Contract AT(11-1)-1198. J. Appl. Phys., 39: 2098-2102(Mar. 1968). (COO-1198-527).

Starting with the hydrodynamic equations for the motion of electrons in a plasma, the electron-plasma-oscillation resonances in a slab geometry have been calculated for various spatial distributions of the initial electron densities and for different electron temperatures. The eigenstates for the perturbed electric field and the electron fluctuation density as well as the resonance frequencies have been computed for the lowest frequency mode and the next-higher frequency mode. Two kinds of mode exist, one having the resonance frequency higher than the maximum local plasma frequency, so that the wave can propagate throughout the entire body of the plasma, and the other having resonance frequencies lower than the maximum local plasma frequency, so that the wave propagation is limited to part of the plasma, and is excluded from a cutoff region. The relationship between the two types of mode is demonstrated. (auth)

19984 SECOND-HARMONIC GENERATION IN PLASMAS BY NONUNIFORM MICROWAVE FIELDS. Kaw, P. K. (Princeton Univ., N. J.); Mittal, R. S. Contract AT(30-1)-1238. J. Appl. Phys., 39: 1975-9(Mar. 1968). (MATT-574).

A Boltzmann-equation analysis is given of the nonlinear generation of the second harmonic in the current density in a slightly ionized plasma, arising because of the nonuniform nature of the applied microwave field. Under suitable approximations, the expression derived for the second-harmonic component in the current density reduces to the one derived on the basis of an elementary theory by Krenz and Kino. Some numerical results, illustrating the effect of collisions on the harmonic generation process, have also been presented. (auth)

19985 ENERGY REQUIREMENT FOR NONLINEAR DENSITY FLUCTUATIONS IN A VLASOV PLASMA. Chen, Robert L. W. (Emory Univ., Atlanta). J. Math. Phys. (N. Y.), 8: 2410-14(Dec. 1967).

Exact solutions of an isoperimetric problem are presented which lead to a lower bound on the kinetic energy of the particles in a Vlasov plasma, in terms of the mean-density fluctuation: $E \geq \frac{3}{2}nkT[1 + 0.4(|\overline{\Delta n}|/n)^2]$, where E is the kinetic energy per unit volume, n the mean number density, k the Boltzmann constant, T the temperature, and Δn the deviation of density. This energy requirement associated with Δn must be taken into account when considering the energetic aspect of the growth of instabilities. The present work, which relies entirely on methematical analysis, confirms the main results of an earlier nonrigorous calculation. (auth)

19986 CONTRIBUTION TO THE STUDY OF IONIZATION AND HEATING OF GASES BY LASER RADIATION. EXPERIMENTAL RESULTS. Veyrie, P. (CEA, Villeneuve-Saint-Georges, France). J. Phys. (Paris), 29: 33-41(Jan. 1968). (In French).

Some experimental results on laser-induced breakdown of gases are considered. Radiation transfer and hydrodynamics of the plasma are emphasized. The rapid increase of the spark volume strongly limits the interacting light flux density. Preionization and ionization threshold are distinguished and measured. (auth)

19987 SCATTERING SPECTRA OF AN ELECTROMAGNETIC WAVE BY A PLASMA JET. Decroisette, Michel (CNRS, Bellevue, France). Ann. Phys. (Paris), 2: 203-8(July-Aug. 1967). (In French).

The scattered spectrum of an electromagnetic radiation incident on a typical laboratory plasma is computed, using Salpeter's theory. It is shown that inhomogeneity of the plasma jet causes important changes, especially in the profile of the two satellite peaks. (auth)

19988 THERMONUCLEAR DETONATION WAVE STRUCTURE. Fuller, Ann L.; Gross, Robert A. (Columbia Univ., New York). Phys. Fluids, 11: 534-44(Mar. 1968).

The structure of a very strong detonation wave (a shock wave followed by a thermonuclear reaction zone) propagating through a deuterium–tritium gas mixture is studied. The shock is sufficiently strong so that it heats the gas to a temperature at which thermonuclear reaction probabilities are large. The characteristic times for collisions and reactions are examined to determine when the von Neumann–Zeldovich model (separate shock and reaction zone) of detonation structure is applicable. Appropriate nuclear reaction kinetics equations are developed for the reaction zone and the effect of energy loss due to bremsstrahlung is included in the analysis. A set of wave structure equations is derived and solved numerically for several different cases. The physical effects expected from a laboratory fast-shock experiment are examined briefly. (auth)

19989 LOCAL DETERMINATION OF THE WAVE-PARTICLE INTERACTION IN WEAKLY TURBULENT PLASMAS. Aamodt, R. E. (Univ. of Texas, Austin. Boeing Scientific Labs., Seattle). Phys. Fluids, 11: 586-94(Mar. 1968). (ORO-3458-8).

The nonlinear effects in weakly turbulent plasmas in the region of particle–wave resonance are shown to be derivable by determining the response of the plasma to an infinitesimal test wave. The local solutions of the test-wave responses are examined and the smearing of the particle–wave resonances and the resulting change in the dispersion relation for the gentle bump instability are determined. The lowest-order nonlinear transport equation is derived and applied to a weak homogeneous beam. (auth)

19990 NONLINEAR EFFECTS IN THE PROPAGATION OF LARGE-AMPLITUDE ALFVEN WAVES IN A LABORATORY PLASMA. Cross, R. C.; Watson-Munro, C. N. (Univ. of Sydney). Phys. Fluids, 11: 557-62(Mar. 1968).

In a cylindrical hydrogenous laboratory plasma source of diameter 21 cm and length 170 cm, the propagation of Alfvén torsional waves of azimuthal wave field b_θ, propagating parallel to a steady magnetic field B_0 in the z direction, have been studied. The perturbation ratio b_θ/B_0 has been increased to values as high as 2.6 and found that: (a) As the perturbation ratio is increased the wave rapidly steepens into a shock wave, but at perturbation ratios in excess of 1.2 there is no further reduction in the rise time of the leading edge. (b) The Alfvén Mach number shows a marked reduction in rate of increase at this perturbation ratio. (c) The attenuation of the wave increases rapidly at this perturbation ratio. (d) There is some evidence of the attenuation energy being expended in particle heating and in the development of a higher-frequency magnetoacoustic wave traveling radially outwards in the plasma. (auth)

19991 THEORY FOR CYCLOTRON HARMONIC RADIATION FROM PLASMAS. Persson, Karl-Birger (National Bureau of Standards, Boulder, Colo.); Johnson, E. G. Jr.; Uhlenbrock, D. A. Phys. Fluids, 11: 619-28(Mar. 1968).

A highly simplified hydrodynamic model for the cause of cyclotron harmonics radiation in a magnetized, abnormal-glow, helium plasma is proposed. The high-velocity electrons are treated as sources for the charge density waves in the plasma. Electromagnetic radiation results from interaction of these wake waves with the statistical fluctuations (the granular structure in the ion density). This radiation contains the cyclotron harmonics. Some numerical curves of the radiation spectra are shown for a number of plasma parameters. (auth)

19992 CHARACTERISTICS OF THE DENSE PLASMA FOCUS DISCHARGE. Mather, Joseph W.; Bottoms, Paul J. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 11: 611-18(Mar. 1968).

The dense plasma focus discharge is produced in a hydromagnetic coaxial plasma accelerator. The final heating and compression of the plasma is accomplished by a partial conversion of the stored magnetic energy residing in the region behind the current sheath to plasma energy. The electrical behavior of the discharge is examined to determine the fraction of the initial energy involved in mechanical sheath motion, inductive storage in the accelerator, and Ohmic losses associated with the external and plasma discharge. Many analyses of this kind of datum show no definite correlation between the energy converted and neutron production. Presumably this arises from a lack of information as to how the collapse uses this energy and to the amount of plasma ejected from the dense plasma region during the collapse. From soft x-ray pinhole and Schlieren photographs, the collapse and the development of the dense plasma is unquestionably a two-dimensional pinch compression. (auth)

19993 EXPERIMENTS ON SHOCK FORMATION IN A Q DEVICE. Andersen, H. K.; D'Angelo, N.; Michelsen, P.; Nielsen, P. (Riso Research Establishment, Roskilde, Denmark). Phys. Fluids, 11: 606-10(Mar. 1968).

Experiments on shock formation in a Q device are described. For equal ion and electron temperatures, $T_i = T_e$, Landau damping prevents shock formation. When the ratio T_e/T_i is made as large as 3 or 4 through ion–neutral atom collisions, shock formation is observed. (auth)

19994 OBLIQUE INCIDENCE OF AN ELECTROMAGNETIC WAVE ON A PLASMA LAYER. Bowman, J. J.; Weston, V. H. (Univ. of Michigan, Ann Arbor). Phys. Fluids, 11: 601-6(Mar. 1968).

A plane electromagnetic wave is obliquely incident upon a plasma

layer of finite thickness, where the equilibrium plasma is taken to be homogeneous and isotropic. The electric vector of the wave is assumed polarized in the plane of incidence. The specular boundary condition for the distribution function is employed and an exact solution of the coupled Maxwell–Vlasov equations is derived as an expansion in normal modes, yielding coupled transverse and longitudinal waves in the plasma region. Temperature effects on the reflection coefficient are investigated. (auth)

19995 STOCHASTIC APPROACH TO THE THEORY OF FLUCTUATIONS IN PLASMAS. Osborn, R. K. (Univ. of Michigan, Ann Arbor). Phys. Fluids, 11: 595-600(Mar. 1968).

A stochastic (in contrast to kinetic theoretic) approach to the calculation of correlation functions in fully ionized plasmas is investigated. Formally different results are obtained. The question as to whether or not the differences are qualitatively and/or quantitatively significant is raised, but not answered. (auth)

19996 ANALYSIS OF A ROTATING PLASMA EXPERIMENT. Sockol, Peter M. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 11: 637-45(Mar. 1968).

In experiments with a homopolar device Fahleson has observed that for low values of the discharge current the voltage drop across the plasma is proportional to the magnetic field and independent of the current and pressure. The rotational velocity corresponds to a kinetic energy for the ions equal to the ionization potential of the gas. These experiments have been analyzed using a steady-state continuum model of the flow in which the bulk of the gas rotates at a uniform velocity and the current is confined to thin Hartmann boundary layers on the end walls. The voltage drop has been calculated as a function of current, pressure, magnetic field, and atomic species. The dependence on these parameters is in good agreement with the measurements under all conditions, while the magnitude of the voltage is generally smaller than the observed value by a factor of 2. (auth)

19997 CYCLOTRON HARMONIC EMISSION ALONG THE FIELD FROM A PLASMA. Wassink, Harry W. (National Bureau of Standards, Boulder, Colo.). Phys. Fluids, 11: 629-37 (Mar. 1968).

Electron cyclotron harmonic radiation from an abnormal negative glow plasma in helium has been measured along the magnetic field with the following results: Single peaks of radiation were observed at the harmonic frequencies which slowly decreased in amplitude with increasing harmonic number; these peaks were almost completely circularly polarized with a polarization opposite to that of the emission by an electron; a large peak was observed near the fundamental in the electron polarization only, harmonic emission appeared only in the presence of the hot electrons produced by electron beams; the difference in the emissions of the two polarizations indicated that most of radiation in the electron polarization came from the end of the plasma and had a large absorption in the interior of the plasma while most of the opposite polarization containing the electron cyclotron harmonic emission came from the interior of the plasma and had a much smaller absorption through the plasma. A theory proposed by Persson, Johnson, and Uhlenbrock showed detailed agreement with these measurements. (auth)

19998 POSSIBILITY OF RADIATION-INDUCED SOUND AMPLIFICATION IN A GAS. Schulz, Michael (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 11: 676(Mar. 1968).

Sound amplification should occur in a gas having an internal mode excited nonthermally, e.g., by sufficiently intense electromagnetic irradiation of the gas at a frequency of the rotational, vibrational, or electronic spectrum of a gas molecule. (auth)

19999 WAVES AT PLASMA–MAGNETIC FIELD INTERFACE. Nakagawa, Y.; Trehan, S. K. (National Center for Atmospheric Research, Boulder, Colo.). Phys. Fluids, 11: 686-7(Mar. 1968).

It is shown that the velocity discontinuity between a plasma–vacuum interface is always unstable to small perturbations when the effect of gravity is taken into account. (auth)

20000 DEVELOPMENT OF MAGNETOHYDRODYNAMIC WAVES BEHIND AN IONIZING SHOCK WAVE. Cowley, M. D.; Morin, S. J. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 11: 674-5(Mar. 1968).

A transverse perturbation to a longitudinal magnetic field is introduced upstream of an ionizing shock. The dominant length scale is given by Ohmic diffusion. Either a transverse structure develops, and one wave is emitted, or two slow waves are emitted. (auth)

20001 ION DENSITY AND ELECTRIC-FIELD PERTURBATIONS CAUSED BY AN ACOUSTIC-WAVE PULSE IN A WEAKLY IONIZED GAS. Ingard, Uno; Schulz, Michael (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 11: 688-9(Mar. 1968).

A weak shock wave in a weakly ionized gas is shown to produce ion density and electric-field perturbations with shock "widths" approximately equal to $(T_e/T_n)l$, where l is the mean free path in the neutral gas and (T_e/T_n) is the electron-to-neutral-gas temperature ratio. (auth)

20002 LANDAU DAMPING IN MAXWELLIAN PLASMAS AS $t \to 0$. Denavit, J. (Northwestern Univ., Evanston, Ill.). Phys. Fluids, 11: 680-2(Mar. 1968).

The linear electric field for longitudinal plasma oscillations is given by a series which does not converge uniformly as $t \to 0$. The difference between the limit of the infinite sum and the sum of the limits of each term is evaluated. (auth)

20003 TEMPERATURE OF EXCITATION AND GAS TEMPERATURE IN RAREFIED ULTRASONIC FLOWS. Odintsova, G. A.; Vaulin, E. P. Zh. Prikl. Spektrosk., 7: 749-51(Nov. 1967). (In Russian).

In ultrasonic plasma jets or argon and mixtures of argon and helium, the excitation temperature was measured by comparison of the intensity of atomic spectral lines. The temperature of the gases of the jet was determined by Doppler broadening of the lines. It was found that the excitation temperature significantly surpassed the gas temperature. In order to explain the results obtained it was assumed that the measured excitation temperature is close to the electron temperature and that the discontinuity of the gas and electron temperatures was produced in the process of plasma expansion in the accelerating jet. (tr-auth)

20004 HELIUM DISCHARGE AT MEDIUM PRESSURES. Golubovskii, Yu. B. Vestn. Leningrad. Univ., Ser. Fiz. Khim., No. 10, 163-4(May 1967). (In Russian).

The theory of a positive column discharge at 5 to 20 torr and 100 to 400 mA is briefly discussed. (M.O.W.)

20005 QUASI-ORTHOGONAL APPROACH TO THE SOLUTION OF PROBLEMS IN PLASMA PINCH DYNAMICS. Savic, P. (National Research Council, Ottawa). pp 707-37 of Recent Advances in Engineering Science. Volume 1. Eringen, A. C. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

From 2nd Technical Meeting of the Society of Engineering Science, East Lansing, Mich. See CONF-641136-(Vol.1).

By a hodograph type of transformation, the "snowplow" equation of the plasma pinch is rendered into a form whereby the nonlinearity is confined to a single term. By analogy with the theory of nonlinear vibrations, the linear part of the problem is expanded in a suitable set of orthogonal functions (Chebyshev Functions of the second kind). It is shown that approximate expressions for pinch time and the distance–time relation may be obtained by suitable modifications of the nonlinear term. The method is shown to be generally applicable to problems of simple pinches or coupled pinch-circuit parameter equations with and without trapped magnetic fields, provided the solution is not extended beyond the shock reflection point. (auth)

20006 ON THE STABILITY OF ELECTROSTATIC OSCILLATIONS IN INHOMOGENEOUS ANISOTROPIC PLASMA. Kammash, Terry; Hall, Laurence S.; Heckrotte, Warren (Univ. of California, Livermore). pp 739-67 of Recent Advances in Engineering Science. Volume 1. Eringen, A. C. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

From 2nd Technical Meeting of the Society of Engineering Science, East Lansing, Mich. See CONF-641136-(Vol.1).

Because of its relevance to plasma containment in thermonuclear devices, the stability of longitudinal oscillations in inhomogeneous magnetized plasma has recently become the object of intense investigation. These so-called "universal instabilities" are presumed to be independent of the configuration of the confining magnetic field, and could arise as a result of coupling between the particle's gyrational motion and the drift motion resulting from spatial inhomogeneity in the plasma density and/or temperature. In this investigation the dispersion equation is derived for electrostatic oscillations in an infinite, collisionless, fully ionized plasma in a uniform magnetic field, in which the particles obey a bi-Maxwellian velocity distribution and where the density has a gradient in a direction perpendicular to the magnetic field. It is found that purely growing modes—as in the Rayleigh–Taylor instability—cannot exist in such a plasma. Furthermore, it is found that oscillations with frequency $\omega = (l + \eta)\Omega_i$, where Ω_i is the ion cyclotron frequency, l is an integer, and $|\eta| \ll 1$, propagating perpendicular to the magnetic field are stable to lowest order in η. A stability condition for oscillations with wave lengths of the order of the ion Larmor radius is presented and discussed. (auth)

20007 INVESTIGATION OF THE FACTORS AFFECTING THE CHARACTER OF THE SPECTRUM OF LASER-PRODUCED PLAS-

MAS. Korunchikov, A. I.; Yanovskii, A. A. Zh. Prikl. Spektrosk., 7: 564-8(Oct. 1967). (In Russian).

The determinative role in the emission of plasma, excited by the reaction of light pulses from lasers on matter, belongs to the luminescent zone caused by the interaction of the plasma jet with air. The production of this zone and the maximum intensity of the spectral lines depends on the energy of the laser emission, its focusing on the surface of the sample, and the motion of the atmosphere surrounding the sample. To use the emission of the plasma most efficiently for spectral analysis it is necessary to take into consideration this dependence, and to set the area of maximum radiation of the plasma on the optical axis of the spectral device. (tr-auth)

20008 VACUUM ULTRA-VIOLET EMISSION SPECTRA FROM LASER-PRODUCED PLASMAS. Burgess, D. D. (Imperial Coll. of Science and Tech., London); Fawcett, B. C.; Peacock, N. J. Proc. Phys. Soc. (London), 92: 805(Nov. 1967).

The electromagnetic emission from plasmas produced by irradiating solid targets with focused light from Q-spoiled ruby lasers was recorded with grazing- and normal-incidence spectrographs as a function of plasma radius and of distance from the target. The plasma density and temperature were thereby evaluated. Observed linewidths of the order of 10^3 cm^{-1} in the grazing-incidence region are ascribed to pressure broadening, with corresponding electron densities in excess of 10^{20} cm^{-3}. The thermodynamic state of the plasma is considered. A brief discussion is given of the effects of varying laser power and target preparation on the degree of ionization of the laser-produced plasma, and on the extension of its use as a spectroscopic source for laboratory astrophysics. (auth) (UK)

20009 DIFFUSION IN PLASMA WITH RECOMBINATION. Luikov, A. V.; Perelman, T. L.; Anisimov, S. I. (Heat and Mass Transfer Inst., Minsk). Int. J. Heat Mass Transfer, 11: 141-4 (Feb. 1968).

The laws of diffusion plasma decay with recombination for different cases of symmetry are considered. (auth) (UK)

20010 OSCILLATIONS OF A NONUNIFORM FINITE-PRESSURE PLASMA. Mikhailovskaya, L. V. Zh. Tekh. Fiz., 37: 1974-83(Nov. 1967). (In Russian).

Maxwell's equations, the heat balance equations for the ions and electrons, and the two-fluid hydrodynamic equations of motion (including the magnetic viscosity term) were used to discuss the oscillations of a nonuniform finite-pressure quasineutral plasma in a magnetic field for the case when the frequency is much lower than the ion–ion collision frequency, the wavelength is much longer than the ion Larmor radius, the propagation vector is nearly perpendicular to the external magnetic field, and the curvature of the lines of force of the external magnetic field is low. When the curvature of the magnetic lines of force is zero and the propagation is perpendicular to the field, the dispersion equation has five roots, of which four represent waves with the electric field perpendicular to the applied magnetic field and one represents transverse drift waves having the electric field parallel to the applied magnetic field. Of the four types of waves other than the transverse drift waves, two (called inertial waves) are significantly affected by the inertia of the ions, and the other two (called noninertial waves) are not. The propagation and stability of these waves are discussed, as well as the effect on them of small curvature of the lines of force of the applied magnetic field and of propagation in a direction not quite perpendicular to the magnetic field. The inertial waves are associated with perturbations of the plasma pressure, and the noninertial waves, with perturbations of the electron and ion temperatures. The inertial waves are more affected than the noninertial waves by curvature of the magnetic field and oblique propagation; in a uniform plasma when the applied magnetic field is not curved, the inertial waves become Alfvén waves when the angle between the propagation vector and the magnetic field becomes significantly less than 90°. (ATD)

20011 INDUCTION PLASMA SOURCE PRODUCING PLASMAS WITH REDUCED IMPURITY CONTENT. I. Kossyi, I. A.; Shpigel, I. S. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 37: 2007-14(Nov. 1967). (In Russian).

A quasi-static field was produced by discharging a 1200-μF capacitor through a system of 8 stainless steel rings surrounding the plasma gun, the oscillation period of the circuit being 500 μsec. The planes of these rings were perpendicular to the axis of the gun, the planes of successive rings were 2.5 cm apart, each ring was 1 cm distant from the wall of the conical plasma gun, the radius of the average ring was 5 cm, and the current flowed in successive rings in opposite directions. The purpose of this quasi-static field was to prevent the accelerating plasma from coming in contact with the plastic wall of the gun. The plasmas were investigated, both within the gun and in the drift tube, with magnetic and electric probes and their compositions at different instants were determined with an electrostatic mass analyzer. In the absence of the quasi-static field the plasmoid at 50 cm from the gun comprised a fast-moving head consisting almost entirely of protons and molecular hydrogen ions, and a slower tail consisting mainly of impurities (mostly carbon and oxygen ions). In the presence of the quasi-static field only the head of the plasmoid could be detected and the impurity concentration was greatly reduced. Probe measurements within the plasma gun showed that in the presence of the quasi-static field, the development of the discharge and the formation of the current sheet took place at some distance from the wall of the gun. At 5 cm from the mouth of the gun, the plasmoid produced in the presence of the quasi-static field contained 2×10^{15} particles. Attempts to obtain larger plasmoids with the aid of the preionization technique described in the reference cited above led to the reappearance of impurities, presumably owing to contamination of the plasma during the preionization stage. Similar results to those described for hydrogen plasmas were also obtained with helium plasmas. (ATD)

20012 MOVEMENT OF A PLASMA IN THE FIELD OF AN ELECTROMAGNETIC WAVE. Gorbunov, L. M. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 54: 205-12(Jan. 1968). (In Russian).

Equations are obtained which describe the motion of a cold plasma due to the pressure of a high-frequency electromagnetic wave moving along a stationary uniform magnetic field. The case of short wave lengths when the geometric optics approximation is valid is investigated in detail. It is shown that, in this case, electrohydrodynamic waves may arise in the plasma. The problem of self-similar spreading of a plasma traversed by an electromagnetic wave is solved. (auth)

20013 CORRELATION OF DENSITY FLUCTUATIONS IN A CLASSICAL IDEAL GAS. Rabinovich, A. I. Zh. Eksp. Teor. Fiz., 54: 239-49(Jan. 1968). (In Russian).

A new method is proposed for calculating the correlations of density fluctuations and the spectra of a classical ideal gas. The method yields results which are identical with those previously known, providing the gas is of infinite dimensions or is enclosed between ideally reflecting screens. New results emerge if the screens absorb the particles and also when fluctuations in the rate of production of gas corpuscles are taken into account. The density correlations can be calculated by means of the derived formulae for an arbitrary Markov, as well as for non-Markov, particle wandering. As an example, the spectrum of the fluctuations of the number of corpuscles is calculated for the case of generation of corpuscles in the volume and diffusion through the boundary. The high frequency asymptotic value of such spectra turns out to differ from that found in previous papers. (auth)

20014 STATISTICAL THEORY OF INELASTIC PROCESSES IN A PLASMA. II. PROCESSES DUE TO A TRANSVERSE ELECTROMAGNETIC FIELD. Klimontovich, Yu. L. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 54: 136-47(Jan. 1968). (In Russian).

A set of kinetic equations for the electron, ion, and atom distribution function of a partially ionized plasma is presented in which all processes due to interaction between the particles and a transverse electromagnetic field are taken into account. By employing the second-moment approximation for the initial microscopic equations, it has been possible to obtain kinetic equations in which polarization of the plasma is taken into account. As a result, the kinetic equations not only take into account the usual processes of photoionization, photorecombination, emission, absorption, etc., but also all so-called super-light ("anomalous") effects. These include, besides the Cherenkov effect, the anomalous Doppler effect and anomalous bremsstrahlung, considered previously by a number of authors in the prescribed medium approximation. Effects of spontaneous and stimulated ionization of atoms involving emission of quanta and of stimulated recombination involving absorption, etc., are also considered. Processes which are taken into account by the collision integral are classified. Equations for the population of atoms for a Maxwellian velocity distribution of plasma particles and also an equation set for the concentration are considered. Expressions are obtained which determine the rates of the ordinary and "anomalous" processes. In particular, expressions are obtained for the photoionization and photorecombination coefficients and for excitation and absorption in a discrete spectrum (Einstein coefficients) by taking into account thermal motion and polarization of the medium. Expressions for the field spectral function and dielectric permeability of a partially ionized plasma are considered. Recombination instability arising in a plasma in

the presence of an excess of nonequilibrium free charged particles in the plasma is studied. (auth)

20015 BINARY DISTRIBUTION FUNCTION OF A DENSE COULOMB GAS. Martynov, G. A. (Inst. of Physical Chemistry, Moscow). Zh. Eksp. Teor. Fiz., 54: 159-74(Jan. 1968). (In Russian).

It is proven on basis of the Bogolyubov equations that the distribution functions $G_{a_1 \ldots a_n}$ of a set of charged particles has a significant singularity at $\rho = 0$ where ρ is the density. Thus they cannot be represented as a series in positive powers of ρ. A method for "splitting" the Bogolyubov equations is proposed which is based on successively taking into account correlations of successively higher multiplicity. It is shown that already in the first approximation the expression for the binary distribution function found in this way is, up to $\rho \approx 0.3$ the same as that obtained by the Monte-Carlo method. (auth)

20016 PLASMA CHEMISTRY IN ELECTRICAL DISCHARGES. McTaggart, F. K. Topics in Inorganic and General Chemistry, Monograph 9. New York, American Elsevier Publishing Co., Inc., 1967. 257p. $17.50.

The following chapters are included: (1) the nature of the plasma, (2) dc, low-frequency, and hf discharges, (3) microwave apparatus, (4) identification and estimation of atomic and free radical species, (5) reactions of hydrogen atoms, (6) reactions of atomic oxygen, (7) reactions of nitrogen atoms, (8) reactions of halogens and other atoms, (9) reactions of radicals, and (10) other dissociations and reactions. (M.O.W.)

20017 INTRODUCTION TO THE DYNAMICS OF RAREFIED GASES. Shidlovskii, V. P. New York, American Elsevier Publishing Co., Inc., 1967. 180p. $12.50.

Translation of Vvedeniye v Dinamiku Razrezhennogo Gaza.

The following chapters are included: (1) elements of the kinetic theory of gases, (2) flows of highly rarefied gases, (3) flow of a slightly rarefied gas, (4) some particular problems of rarefied gas dynamics, and (5) the gas dynamics of rarefied plasmas. (M.O.W.)

20018 ELECTRODYNAMICS OF PLASMAS. Jancel, R.; Kahan, Th. New York, John Wiley and Sons, Inc., 1966. 647p. $19.95.

The following chapters are included: (1) general properties of plasmas and elementary processes, (2) principles of statistical mechanics, (3) classical dynamics of binary collisions, (4) motion of charged particles in electric and magnetic fields; Brownian motion of charge carriers, (5) Boltzmann equation; fundamental properties; Maxwell transport equations, (6) macroscopic relations; equations of dynamics and hydrodynamics of plasma, (7) the H theorem; the properties of the Maxwellian state of plasmas; the mean free path; application to transport phenomena, and (8) general methods of approximate solution of Boltzmann's equation. (M.O.W.)

20019 PLASMA PHYSICS. Tannenbaum, B. Samuel. McGraw-Hill Physical and Quantum Electronics Series. New York, McGraw-Hill Book Co., 1967. 370p. $13.50.

The following six chapters are included: motion of a charged particle in electromagnetic fields, magnetoionic theory, continuum equations for a plasma, the Boltzmann–Vlasov equation for a plasma, the Boltzmann equation for a plasma, and the BBGKY equations for a plasma. (M.O.W.)

Production of Plasma

20020 (IAE-1364) KASKADNOE VOZBUZHDENIE ATOMA VODORODA PRI PROKHOZHDENII CHEREZ PLAZMENNUYU MISHEN'. (Cascade Excitation of the Hydrogen Atom During Passage Across a Plasma Target). Grechukhin, D. P.; Karpushkina, E. I. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1967. 60p. (In Russian). Dep.

The cascade excitation of a hydrogen atom passing through plasma is analyzed. The following cases are considered: a) the plasma exists in a magnetic field resulting in the ionization of highly excited states of the atom; b) there is no magnetic field in the plasma. The calculations are intended to elucidate the principal characteristic features of the cascade process and to estimate the possibilities for utilizing this excitation mechanism in the injection of neutrals into magnetic traps. The "fast flight" method is used to estimate the ionization cross sections of highly excited atoms of hydrogen due to ionization by fields of the atom, ion, electrical dipole and quadrupole. (JPRS)

20021 TIME CONSTANTS FOR NONSTATIONARY ARCS. Phillips, Richard L. (Univ. of Michigan, Ann Arbor). Z. Phys., 211: 113-31(Mar. 19, 1968).

The time constants associated with the initial deviations of an arc column from a static state have been studied analytically. The basic approach is to use a Taylor series expansion in powers of time of the energy balance equation. It is assumed that the arc gas is optically thin and is in local thermal equilibrium. Initially the effects of radial gas flow (which must exist for dynamic arcs) are neglected, but this simplification is later relaxed. The initial conditions are given by the properties of a cylindrically symmetric, wall-stabilized dc positive column. The interrupted (freely decaying) and the step-modulated arcs are considered, and initial time constants for conductance, electric field, and heat flux potential are computed. For numerical results the best available values of thermodynamic and transport properties have been used. (auth)

20022 AFTERGLOW IN HELIUM AND NEON. Allab, Daho (Laboratoire de Physique Electronique, Orsay, France). J. Phys. (Paris), 29: 22-32(Jan. 1968). (In French).

A centimetric wavelength reflectometer was described previously, which allows measurements of electron density n, and collision frequency ν, in an afterglow plasma. Attention is given to the results of measurements. The shapes of the decay of electronic density show that the plasma disappears by collisional-radiative recombination. Furthermore, measurements made on the collision frequency show: (1) That the gas of electrons cools down faster in the case of a helium afterglow than in the case of a neon afterglow; (2) That, at the beginning of the afterglow, the rate of decrease of temperature is much more important than the rate of decrease of density. (auth)

20023 PRODUCTION OF QUIESCENT DISCHARGE WITH HIGH ELECTRON TEMPERATURES. Lisitano, G.; Ellis, R. A. Jr.; Hooke, W. M.; Stix, T. H. (Princeton Univ., N. J.). Rev. Sci. Instrum., 39: 295-7(Mar. 1968). (MATT-539).

Collision-free quiescent plasmas are produced in a magnetic mirror geometry by applying ~50 W uhf power to a novel coupling structure which surrounds one section of the plasma. The plasma characteristics are favorable for studies of waves, diffusion, stability, and turbulence. (auth)

20024 SHOCK WAVES IONIZING A GAS IN AN ELECTROMAGNETIC FIELD. Barmin, A. A.; Kulikovskii, A. G. (Mathematical Inst. Moscow). Dokl. Akad. Nauk SSSR, 178: 55-8(Jan. 1, 1968). (In Russian).

Shock waves which change the electric conductivity of a gas within a randomly oriented magnetic field from zero to infinity were investigated. The correlations involved in the structure of such waves are not derived from the laws of the conservation of mass, impulse, energy and the continuity of the tangential component of the electric field. The fact that the Hall effect was not considered in the study does not change the conclusions reached. The structure of the shock wave in the gas was examined on the basis of the thermal and electric conductivity, assuming that in the range in which the electrical conductivity is larger than zero, the structure of the ionizing shock wave is represented by a stationary solution of the magnetohydrodynamic equation; where the conductivity is zero, the gas dynamic equation is to be used. The types of waves examined included fast ultrasonic, fast sonic, intermediate ultrasonic, intermediate sonic, slow ultrasonic and slow sonic waves. All the shock waves studied had an evolutionary character. (TTT)

20025 NONEQUILIBRIUM IONIZATION IN LOW-VOLTAGE ARC WHEN INELASTIC SCATTERING CROSS SECTIONS ARE LARGE. Stakhanov, I. P. Zh. Tekh. Fiz., 37: 2067-77(Nov. 1967). (In Russian).

The non-Maxwellian distribution of electron velocities in the vicinity of the cathode of a low-voltage hot-cathode arc is discussed. The calculations are of technical interest in connection with low-voltage cesium-arc thermoelectronic energy converters. The thermal distribution of the velocities of the emitted electrons is taken into account and it is assumed that the cross section for inelastic scattering of an electron on an atom is large when the electron energy exceeds the threshold (the energy of the first excited state of the atom). It is also assumed that the velocity distribution of the fast electrons is isotropic as a result of elastic collisions with atoms. The Wiener–Hopf method is found to be inadequate for an accurate calculation of the distribution function. The distribution function is calculated by a method that was developed in the theory. With the aid of the distribution function, expressions are derived for the rate of ionization, including the contribution from the non-Maxwellian electrons. (ATD)

Stability of Plasma

20026 (IAE-1331) IONNO-TSIKOLOTRONNAYA NEUSTOICHIVOST' PLAZMY V ADIABATICHESKOI LOVUSHKE S "MINIMUMOM B". (Ion-Cyclotron Instability of Plasma in an Adia-

batic Trap with a "B Minimum"). Baiborodov, Yu. T.; Ioffe, M. S.; Sobolev, R. I.; Yushmanov, E. E. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1967. 28p. (In Russian). Dep.

The occurrence of cyclotron instability in the presence of a plasma density of $\sim 5 \times 10^8$ cm^{-3}, ion energy of ~1 keV and magnetic-field intensity of 3000 Oe is investigated. The instability manifests itself in the form of discrete bursts lasting 30 to 40 μsec, accompanied by hf oscillations and the ejection of plasma onto the walls. Different bursts may markedly differ in their nature. The magnitude of plasma ejection onto the wall corresponds to the observed decrease in density. The distribution of the plasma flux over the walls indicates that losses along and across the magnetic field are comparable in magnitude. The rotation of the velocity vectors in the direction of the forbidden cone for a large part of the ions is also indicated by the marked longitudinal expansion of the plasma during an instability burst. The hf signal has a line structure with a predominant first harmonic corresponding to the ion-cyclotron frequency. The size of the electrical-field amplitude warrants the assumption that the plasma develops longwave oscillations with $\lambda \approx 30$ cm that are characterized by a marked (to the extent of several percent) perturbance of the quasineutrality of the plasma and by potential oscillation amplitudes of the order of kilovolts. Quantitative comparison of the available experimental findings with the theory of the cyclotron instability of homogeneous plasma results in conflicting findings. (JPRS)

20027 (MATT-Trans-53) POSSIBLE CAUSE OF PLASMA TURBULENCE IN A HIGH CURRENT TOROIDAL DISCHARGE. Larionov, M. M.; Rozhdestvenski, V. V. (Akademiya Nauk SSSR, Moscow. Fiziko-Tekhnicheskii Institut). Translated for Princeton Univ., N. J., from a Russian Report. 12p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

It is shown that under the discharge conditions turbulent phenomena in the plasma are caused by the development of convective instability, and this type of instability limits further increase in the plasma temperature. (M.O.W.)

20028 INFLUENCE OF TEMPERATURE PERTURBATIONS ON THE STABILITY OF PLASMA. Moiseev, S. S. Zh. Prikl. Mekh. Tekh. Fiz., No. 6, 3-6(Nov.-Dec. 1967). (In Russian).

The electron–ion friction which is a function of the current density in an inhomogeneous plasma, leads to a drift-dissipative instability friction as the result of the electron temperature gradient in the plasma; its role is determined by the prevailing temperature perturbations. This problem was more closely examined, deriving the dispersion equation by an approximation method on the basis of the perturbation potential; the inertial drift of ions and the finite character of the ionic Larmor radii were neglected. A study of the longitudinal movement of the electron and ionic gases indicated that the perturbation of electron and ion temperatures must be taken into account, even if the plasma is homogeneous. Curvature of the lines of force may also exert a specific effect. (TTT)

20029 INSTABILITY OF COUPLED LONGITUDINAL AND TRANSVERSE ELECTROMAGNETIC MODES OF WAVE PROPAGATION IN BOUNDED STREAMING PLASMAS. Bhatnagar, P. L. (Indian Inst. of Science, Bangalore); Raghvachar, M. R.; Uberoi, C. J. Appl. Phys., 39: 1948-56(Mar. 1968).

The instability of coupled longitudinal and transverse electromagnetic modes associated with long wavelengths is studied in bounded streaming plasmas. The main conclusions are as follows: (i) For long waves for which $O(k^2) = 0$, in the absence of relative streaming motion of electrons and ions and $\alpha\omega_p/c < 0.66$, the whole spectrum of harmonic waves is excited due to finite temperature and boundary effects consisting of two subseries. One of the subseries can be identified with Tonks–Dattner resonance oscillations for the electrons, and arises primarily due to the electrons with frequencies greater than the electrostatic plasma frequency corresponding to the electron density in the midplane in the undisturbed state. The other series arises primarily due to ion motion. When $\alpha\omega_p/c > 0.66$, in addition to the above spectrum of harmonic waves, the system admits an infinite number of growing and decaying waves. The instability associated with these modes is found to arise due to the interaction of the waves inside the plasma with the external electromagnetic field. (ii) For modes with comparatively shorter wavelengths for which $O(k^3) = 0$, the coupling due to finite temperature sets in, and it is found that the two series of harmonic waves obtained in (i) deriving energy from the transverse modes also become unstable. Thus, for these wavelengths the system admits three sets of growing and decaying modes, first two for all values of $\alpha\omega_p/c$ and the third for $(\alpha\omega_p/c) > 0.66$. (iii) The presence of streaming velocities introduces various other coupling mechanisms, and it is found that even for the wavelengths for which $O(k^2) = 0$, three sets of growing and decaying waves are produced. The numerical values for the growth rates show that the streaming velocities enhance the growth rates of instability significantly. (auth)

20030 STRUCTURE OF PLASMA TURBULENCE DUE TO NONLINEAR CROSS-FIELD INSTABILITY. Tsuda, Takao; Sato, Tetsuya (Kyoto Univ.). Phys. Fluids, 11: 676-8(Mar. 1968).

Evolution of spectral distribution of charge-density fluctuations in a strong plasma turbulence is studied by computer. It is demonstrated that components of sufficiently short wavelengths are strongly modulated by long wavelength components, but not the other way. (auth)

20031 DRIFT INSTABILITIES IN GENERAL MAGNETIC FIELD CONFIGURATIONS. Rutherford, P. H.; Frieman, E. A. (Princeton Univ., N. J.). Phys. Fluids, 11: 569-85(Mar. 1968). (MATT-569).

A theory of low-frequency drift (universal) instabilities in a nonuniform collisionless plasma is developed for general magnetic field configurations including trapped particle effects, rather than the plane geometry which has previously received most attention. A type of energy principle shows that the special equilibrium distribution $F(\epsilon, \mu)$, of interest in minimum-B mirror configurations, is absolutely stable to these modes provided $\partial F/\partial \epsilon < 0$ together with a second condition on $\partial F/\partial \mu$. For equilibrium distributions not of this special form, in particular for a Maxwell distribution with a density gradient, the case of axisymmetric toroidal configurations with closed poloidal field lines is considered in detail. Three unstable drift modes are found, a flute-like mode, a drift-ballooning mode local to the region of unfavorable curvature, and a drift-universal mode. Stability criteria and growth rates for the modes are given. The equations also describe a recently discussed low-frequency trapped-particle instability. (auth)

20032 STABILITY OF A NONSTATIONARY PLASMA. Wu, C.-S. (Univ. of Maryland, College Park). Phys. Fluids, 11: 683-6(Mar. 1968).

The stability of a nonstationary plasma is studied. It is concluded that the single-humped distribution is not necessarily stable. The result is applied to the case of the electron plasma wave. (auth)

20033 OBSERVATION OF THE NEGATIVE-MASS INSTABILITY IN A PLASMA BETATRON. Ferrari, L. A. (Queens Coll., New York); Rogers, K. C.; Landau, R. W. Phys. Fluids, 11: 691-3(Mar. 1968).

The beam disruption times observed in a plasma betatron experiment are compared with those predicted by the negative-mass instability. Agreement with theory is found for a wide range of data. (auth)

20034 STABILITY OF A SOLID CONDUCTING CYLINDER IN MAGNETIC FIELD OF CURRENT PASSING THROUGH IT. Vandakurov, Yu. V.; Kolesnikova, E. N. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 37: 1984-92(Nov. 1967). (In Russian).

In earlier work on the disruption of wires by high-current pulses, evidence was found that magnetohydrodynamic instabilities of the screw and sausage types develop and that the screw instability can arise before the conductor melts. In the present paper the possibility of such instabilities arising in a poorly conducting solid elastic cylinder carrying a current is discussed. The magnetoelastodynamic equations are linearized for a small perturbation of the form $F(r) \exp(i(m\Theta + kz + ft)$, where r, Θ, z are cylindrical coordinates, t is the time, and m, k, and f are constants, m being necessarily integral. The dispersion equation was solved numerically with a computer for m = 0 (sausage instability) and m = 1 (screw instability), and the results are presented as curves giving the imaginary frequency for different values of Poisson's ratio and dimensionless parameters representing the strength of the current and the wavelength of the perturbation. The results of the calculations show that the m = 1 perturbations, but not the m = 0 ones, can become unstable while the conductor is still solid. The predicted wavelength of the screw instability having the most rapid growth rate agrees with the earlier experimental results. (ATD)

Shielding

Refer also to abstracts 19350, 19392, and 20396.

20035 (UCRL-50358) SORS MONTE CARLO PHOTON-TRANSPORT CODE FOR THE CDC 6600. Kimlinger, John; Plechaty, Ernest F.; Terrall, John R. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 4, 1967. Contract W-7405-eng-48. 44p. Dep. CFSTI.

The SORS Monte Carlo photon-transport code is a two- or three-dimensional program for calculating the transport of photons in the energy range from 1.0 keV to 15.0 MeV. (auth)

20036 ON THE FUNDAMENTAL MODE DECAY CONSTANT FOR A SPHERICAL ASSEMBLY (ONE-VELOCITY CONSIDERATION). Bansal, N. K.; Ghatak, A. K. (Indian Inst. of Tech., New Delhi). Can. J. Phys., 46: 318-9(Feb. 15, 1968).

For a spherical assembly, the fundamental mode and the corresponding decay constant of the monoenergetic neutron transport operator have been obtained. The anisotropy of scattering has been taken into account. (auth) (Canada)

Solid-State Physics

Refer also to abstracts 18790, 19160, 19183, 19200, and 19223–19225.

20037 (COO-525-30) STUDIES OF IMPERFECTIONS IN SOLIDS. Progress Report. (Nebraska Univ., Lincoln). Feb. 1968. Contract AT(11-1)-525. 33p. Dep. CFSTI.

Design of a calorimeter to be used for measurements of stored energy in alkali metal halide crystals in the temperature range -190 to 400°C is described. Data on the intensity of x rays scattered from Pb are included. The data are investigated for the presence of Kohn anomalies due to electron–phonon interactions. Plans for the investigation of the dynamical properties of other crystals using x-ray thermal diffuse scattering are discussed briefly. A Phillips x-ray diffractometer being prepared for measurements of elastic constants of chromium and Debye–Waller factors of cesium halides is described. Some data are given on scattering of x rays by Cr. (A.G.W.)

20038 (COO-1052-9) INVESTIGATION OF ENERGY TRANSFER PROCESSES BY FLASH PHOTOLYSIS (RADIATION EFFECTS IN SOLIDS). Progress Report No. 10, February 1967–February 1968. Grossweiner, Leonard I. (Illinois Inst. of Tech., Chicago. Dept. of Physics). Contract AT(11-1)-1052. 17p. Dep. CFSTI.

Recent measurements of KCl fracture surface energy by the slow-cleavage technique show that ^{60}Co irradiation induces a fracture energy increase proportional to the dose. Experiments with additively colored KCl show that the major changes are not caused by the F centers. The absorption spectrum of the R-center quartet state in γ-irradiated NaCl was resolved by dichroic low-temperature bleaching measurements. The resulting energy diagram is similar to that deduced for the R center in KCl based on the stress-induced splitting of the spectra. Similar results were obtained on γ-irradiated KI. The mechanism of optical conversion of F centers to M and R centers in KCl was investigated by the repetitive light-pulse method. The initial conversion rates increase with increasing pulsing period and are independent of the initial F-center concentration. The data are in good agreement with a kinetic model in which F' centers coalesce with nearby negative ion vacancies to form the M centers. The formation of R centers competes with the growth of M centers in the early stages. A refined apparatus was used to continue work on dye sensitization of zinc oxide photoconductivity. The new work supports the proposed theory in which the transfer of electrons from zinc oxide to the dye film establishes a Schottky barrier in the dark. Results with eosin indicate that the mechanism applies for dye films varying from monolayers to at least 10 layers thick. (A.G.W.)

20039 (COO-1488-9) INTERACTIONS BETWEEN PARAMETRICALLY EXCITED SPIN WAVES IN YTTRIUM IRON GARNET. Bierlein, John D. (Kansas Univ., Lawrence. Dept. of Physics). 1968. Contract AT(11-1)-1488. 140p. Dep. CFSTI.

Accurate measurements were made that show the steady-state and transient dependence of both $M_z(2\omega)$ and the uniform mode on applied microwave field for fields above and below Suhl threshold. These data are then compared with a theory developed here which shows that many interesting effects can be explained in terms of the parametric nature of higher-order spin wave interactions. This investigation has provided a study of parametric interactions among spin waves, the fundamental excitations in magnetic insulators. The normal mode theory of ferrimagnetic resonance following closely the approach of Suhl and Schlömann. The present theory is applicable only for narrow line-width samples. The effects of higher order interactions among spin waves excited by the Suhl processes are considered. Relations for the second harmonic contribution to the z-component of magnetization are derived for cases where zero, one, and two spin wave pairs are excited. A simple vector model is presented from which the general characteristics of both the steady-state and transient response of $M_z(2\omega)$ readily can be determined. An approximate many spin wave approach is derived which gives much better quantitative agreement than the relatively simple two-spin-wave-pair model. The general characteristics of the observed second harmonic line profile can also be reproduced using this method. (M.H.R.)

20040 (COO-1629-3) THERMAL MEASUREMENTS ON SOLIDS BELOW 1°K. Progress Report No. 2. Weinstock, Harold (Illinois Inst. of Tech., Chicago. Dept. of Physics). Jan. 1968. Contract AT(11-1)-1629. 25p. Dep. CFSTI.

Measurements of thermal conductivity in the range 0.4 to 4.0°K were carried out on initially high-purity KCl single crystals subjected to various radiation and temperature treatments. The results indicate a resonant-type decrease in conductivity below 1°K in specimens given high doses (~10^8 to 10^9 R) of gamma radiation at room temperature and possessing correspondingly high (~10^{18}/cm^3) F-center concentrations. This behavior is interpreted in terms of a geometrical scattering resonance. A crystal irradiated at liquid-nitrogen temperature and measured immediately showed a relatively low conductivity, which increased considerably after cycling to room temperature. This suggests a recombination or annealing of lattice defects between 77 and 300°K. A cryostat designed to measure thermal conductivity in a high magnetic field down to 0.3°K and a facility for growing single crystals large enough and perfect enough for thermal conductivity measurements are described. (A.G.W.)

20041 (NP-17314) METHODS OF OBTAINING MONOCHROMATIC X-RAYS AND NEUTRONS. Bibliography 3. Herbstein, F. H. (ed.) (International Union of Crystallography. Commission on Crystallographic Apparatus). 1967. 84p. Dep.

The bibliography is divided into four parts under the following headings: general references, monochromation of x rays by balanced filters, monochromation of x rays by crystals, and monochromation of neutrons. The references in each part are organized on a chronological basis, and each part is accompanied by an author index. Short abstracts in English are given for most papers. (A.G.W.)

20042 (ORO-3764-1) MAGNETIC PHENOMENA AT METAL SURFACES. Technical Progress Report No. 1, June 1–December 31, 1967. Spooner, Stephen (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Feb. 29, 1968. Contract AT-(40-1)-3674. 33p. Dep. CFSTI.

Cobalt and cobalt–6% iron alloy films have been prepared for magnetic-property study and neutron-scattering measurements. Rotational anisotropy and hysteresis have been measured using torque magnetometer techniques. There are indications of possible "ripple" structure in these films where fields in the order of 500 gauss are applied. Preliminary neutron-scattering experiments measuring total external reflection at grazing incidence have indicated the possibility of neutron polarization. Magnetic fields up to seven kilogauss have been applied in the direction of the plane of cobalt mirror, and only small effects are observed. A novel technique for measuring the magnetic structure at surfaces has been devised with the application of a "magnetic needle." Based on a force measurement due to fields in the immediate vicinity of a magnetic surface, the method can be used to measure domain structure and external field variations needed for understanding of the neutron-scattering experiment. (auth)

20043 (AD-663351) ACADEMY OF SCIENCES OF THE LATVIAN SSR. INSTITUTE OF PHYSICS. RADIATION PHYSICS (COLLECTION OF ARTICLES). Translation of Radiats. Fiz., Akad. Nauk Latv. SSR, Inst. Fiz., 1: 1-184(1964). 177p. (FTD-MT-65-370). CFSTI.

Results of research on radiation defects, microstructure of impurity centers, and radioluminescence of alkali-metal-halide crystals are collected here. Nine of the seventeen articles were cataloged from the original Russian and appear separately as NSA 19: 9209, 24185, and 34238 to 34244; these articles involved radiation effects. The other eight articles are concerned with basic luminescence studies on alkali-metal-halide phosphors and were considered outside the scope of NSA. (L.M.T.)

20044 (JPRS-44148) EFFECT OF HIGH-ENERGY RADIATION ON CERAMIC DIELECTRICS. Kostyukov, N. S.; Smirnova, T. M. Translated from Tr. Gos. Issled. Elektrokeram. Inst., No. 4, 120-7(1960). 10p. CFSTI.

The irradiation was carried out with 1.3-MeV γ quanta, for which the most probable mechanism of interaction of the γ rays with the substance is the Compton Effect, and with energies of 30 to 260 MeV, for which photonuclear reactions are most probable. (M.H.R.)

20045 MAGNETIC MOMENT OF THE 139-keV LEVEL IN ^{193}Ir AND THE MAGNETIC HYPERFINE INTERACTION IN AN Fe–Ir ALLOY. Gustafsson, S.; Johansson, K.; Karlsson, E.;

Norlin, L. O.; Svensson, Aa. G. (Univ. of Uppsala). Ark. Fys., 34: 169-89(1967).

The nuclear magnetic moment of the 139 keV level in ^{193}Ir and the hyperfine magnetic field at the iridium nuclei in an Fe–Ir alloy were measured by the method of perturbed angular correlations. Some investigations of the ^{193}Os decay scheme are presented in the form of coincidence spectra obtained with conventional NaI(Tl) scintillation detectors as well as a Ge(Li) detector. The angular correlations of the 321 → 139 keV and 387 → 73 keV cascades were measured. The mixing ratio of the 321 keV transition and was determined to be 0.18 less than or equal to the magnitude of delta less than or equal to 0.24; delta less than zero. The isotropic 387 → 73 keV angular correlation supports the spin ½ assignment of the 73 keV level. The value of the nuclear magnetic moment (0.68 ± 0.11) n m indicates that the 139 keV level can be interpreted as a rotational state based on the ground state. The hyperfine field value, –(1.64 ± 0.23) MG, is consistent with previous results from NMR and nuclear specific heat measurements. (auth) (Swed)

20046 ELECTRON SPIN RESONANCE SPECTRA OF GAMMA-RAY-IRRADIATED PHOSPHATE GLASSES AND COMPOUNDS: OXYGEN VACANCIES. Weeks, R. A. (Oak Ridge National Lab., Tenn.); Bray, P. J. Contract AT(30-1)-2024. J. Chem. Phys., 48: 5-13(Jan. 1, 1968).

The electron spin resonance spectra of γ-irradiated glassy and polycrystalline phosphorus pentoxide and alkali phosphates with molar ratios of phosphorus pentoxide to alkali oxide ranging from 3.33 to 0.625 have been observed at 10 and 35 Gcps and at 300 and 78°K. Well-resolved hyperfine doublets were observed in each glass or polycrystalline powder. Additional resonances were also present in all the specimens, but these are not discussed. The widths and shapes of the doublets were independent of temperature and only small alterations in the shapes of each component of a doublet were found as a function of frequency. One set of doublets has been discussed elsewhere and is not considered. Those doublets discussed are attributed to an electron trapped at a nonbridging oxygen vacancy. Interaction of the electron with the nearest-neighbor ^{31}P nucleus (100% natural abundance, I = ½) produces the doublet structure. These doublets exhibited isotropic hyperfine interactions ranging from 1880 to 4490 Mcps. The smaller interactions, 1880 to 2196 Mcps, were found in glasses and polycrystalline powders with molar ratios ≤1 and the larger interactions, 2630 to 4490 Mcps, were found in those with molar ratios >1. The anisotropic hyperfine interaction, $(A_{||} - A_{\perp})/h$, of all the doublets was ≤540 Mcps. The defect electron state is assumed to be the nonbonding phosphorus sp hybrid orbital. On the basis of this assumption, the different isotropic hyperfine interactions are attributed to different geometric configurations of the phosphorus ion and the oxygens to which it is bonded. The assumed sp hybridization accounts for most of the electron density. An approximate g value is calculated for the doublets and is found to range from 2.005 to 2.040. (auth)

20047 APPROACH TO HIGH-RESOLUTION NMR IN SOLIDS. Waugh, J. S.; Huber, L. M.; Haeberlen, U. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 20: 180-2(Jan. 29, 1968).

A method for reducing static dipolar broadening in NMR experiments on solids is described briefly. The theory is outlined, and results are shown for a sample consisting of a small single crystal of CaF_2 and some liquid $C_6H_5CF_3$. Possible further improvements in the method are considered. (A.G.W.)

20048 EFFECT OF TEMPERATURE ON SURFACE CHARGES CAUSED BY AN INCIDENT ELECTRON BEAM ON A METALLIC SURFACE. Petit-Clerc, Y.; Carette, J.-D. (Univ. Laval, Quebec). Appl. Phys. Lett., 12: 227-8(Apr. 1, 1968).

Measurements have been made of the effects of a temperature increase on surface charges caused by electron bombardment of an aluminum surface. At 200°C surface charges are still present although reduced by a factor 4. At this temperature the life of the surface charges is much shorter than at room temperature. (auth)

20049 IDENTIFICATION OF VACANCY AND INTERSTITIAL LOOPS IN NEUTRON-IRRADIATED MOLYBDENUM. Maher, D. M.; Eyre, B. L. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag., 17: 1-6(Jan. 1968).

Transmission electron microscopy was used to investigate point defect aggregates resolvable as dislocation loops in neutron-irradiated and annealed molybdenum. The so-called formal analysis was employed in determining the direction and sense of their Burgers vectors. In foils containing a wide spectrum of loop sizes, both vacancy- and interstitial-type loops were identified, with Burgers vectors of the type a/2(111). (auth) (UK)

20050 GENERATION OF FOCUSED COLLISION SEQUENCES IN IRRADIATED CRYSTALS: A CALCULATION BASED ON THE INVERSE SQUARE POTENTIAL. Sanders, J. B. (FOM-Institut Amsterdam); Thompson, M. W. Phil. Mag., 17: 211-14(Jan. 1968).

Of central importance in radiation damage theory is the function X(E,E')dE' giving the number of focused collision sequences generated with energy in the interval dE' at E' by a primary recoil of energy E. Previous calculations have used a hard-sphere model for interatomic collisions in a collision cascade. In this paper the calculations for the cascade are based on collisions with an interaction potential depending on the inverse square of the interatomic separation. Focused collisions are treated with a Born–Mayer potential A exp (–r/b). It is shown that when this method is used to predict the energy spectrum of sputtered atoms, better agreement with observations is obtained than with the previous hard-sphere models. (auth) (UK)

20051 ZERO-POINT ENERGY AND θ_c^m FOR SOME bcc METALS. Sharan, B.; Chandra, M. (Indian Inst. of Tech., New Delhi). J. Chem. Phys., 48: 1407-8(Feb. 1, 1968).

The method of moments and recent phonon spectra were used to evaluate the zero-point energy, E_0, for eight bcc metals. The value of the Debye temperature as $T \to \infty$, θ_c^m, was obtained from an expression for heat capacity by Domb and Salter [Phil. Mag., 1083: (1952)], and E_0 was also calculated from the formula $E_0 = (9/8)Nk\theta_c^m$. Results are tabulated for Li, Na, K, V, αFe, Mo, Ta, and W. Results from the two methods agree satisfactorily. (A.G.W.)

20052 SPIN-RESONANCE PROPERTIES OF SCHEELITES. I. VANADIUM IN $CaWO_4$. Mahootian, N. (Univ. of Michigan, Ann Arbor); Kikuchi, C.; Viehmann, W. J. Chem. Phys., 48: 1097-1102(Feb. 1, 1968).

The first of a series of investigations directed at obtaining information about charge compensation in $CaWO_4$ is reported. Vanadium, which lies immediately above niobium in the periodic table, is introduced as the microprobe. The EPR spectra produced by x irradiation and observed at 77° and 4.2°K indicate that vanadium can occupy a variety of sites. Arguments are given that two of these, referred to as Group A and Group C, are due to vanadiums in W and Ca sites, respectively. (auth)

20053 X-RAY EXTINCTION RULES AND RADIATION DAMAGE EFFECT IN ROCHELLE SALT. Shiozaki, Yoichi (Hokkaido Univ., Sapporo). J. Phys. Chem. Solids, 28: 2381-4(Dec. 1967).

It has been found that odd (0k0) Bragg reflections can be observed with x rays in the ferroelectric phase of Rochelle salt, as were observed with neutrons by Frazer et al., (1963). The integrated intensity of the (050) reflection is proportional to the squared spontaneous polarization. X-ray dosage up to 1.5×10^5 erg/cm^2 caused a practically negligible change in the intensity of (050) Bragg reflection. The (300) and (500) Bragg reflections have been observed, but they seem to be caused by the double reflection. (auth) (UK)

20054 STUDIES OF XENON CHLORIDES AND OTHER XENON COMPOUNDS BY THE MOESSBAUER EFFECT IN ^{129}Xe. Perlow, G. J.; Perlow, M. R. (Argonne National Lab., Ill.). J. Chem. Phys., 48: 955-61(Feb. 1, 1968).

The compounds $XeCl_2$ and $XeCl_4$ have been made in the beta decay of ICl_2^- and ICl_4^- containing radioactive ^{129}I. The electric quadrupole interaction in the 39.6-keV excited state of the ^{129}Xe nucleus is employed to study these substances by the Mössbauer effect. The decay products are compared with XeF_2 and XeF_4 and with the parent ions. It is shown that the decays $ICl_2^- \to XeCl_2$ and $ICl_4^- \to XeCl_4$ both result in the recall of 0.2 electrons per bond from each ligand to the central atom. In the xenon halides the charges per fluorine are –0.72 and per chlorine are –0.5. The assumption of pure p_σ bonding in the xenon halides is tested by the isomer shifts. With its aid the shifts can be calibrated by the quadrupole couplings. A shielding constant obtained from Hartree–Fock calculations by Wilson is then used to relate p-electron to s-electron transfer, which is next employed to examine the charges on the xenon atom in XeO_4 and XeO_6^{-4}. The former is prepared in beta decay, the latter equivalently either in beta decay or in bulk. It is shown that directed sp^3d^2 hybrid bonds for XeO_6^{-4} are inconsistent with the measured isomer shift. The recoilless fractions and linewidths are tabulated for a number of xenon compounds. (auth)

20055 OPTICAL SPECTRA OF Pu IN CaF_2. McLaughlin, R.; White, R.; Edelstein, N.; Conway, John G. (Univ. of California, Berkeley). J. Chem. Phys., 48: 967-9(Feb. 1, 1968).

The optical spectra of Pu^{3+}, Pu^{4+}, and color centers in CaF_2 have been measured. Tetravalent Pu and the color centers are

formed in the crystal as the result of the decay of the Pu nucleus. Fluorescence spectra of Pu^{3+} and Pu^{4+} are also obtained. (auth)

20056 PARAMAGNETIC RESONANCE OF I_2^- CENTERS IN PH_4I SINGLE CRYSTALS. Marquardt, Charles L. (Naval Research Lab., Washington, D. C.). J. Chem. Phys., 48: 994-6 (Feb. 1, 1968).

The I_2^- centers have been produced by x irradiation of PH_4I crystals at liquid-nitrogen temperature and have been studied by electron paramagnetic resonance. The molecular axes of the centers were inclined 14.4° from the (001) plane, as might be expected from the crystal structure of PH_4I. Constants of the spin Hamiltonian of I_2^- in PH_4I have been determined to be $g_{||} = 1.901$, $g_\perp = 2.28$, $A_{||} = 364$ G, $A_\perp = 73$ G, and $|Q'| = 68$ G. From this data the admixture of $^2\Pi_u$ wave function into the $^2\Sigma_u^+$ ground state of I_2^- is estimated to be about 15%. (auth)

20057 MOESSBAUER EFFECT AND MAGNETIC PROPERTIES OF IRON–BERYLLIUM COMPOUNDS. Ohta, Keizo (Univ. of Southern California, Los Angeles). J. Appl. Phys., 39: 2123-6 (Mar. 1968).

Moessbauer measurements using ^{57}Fe were made on the Fe–Be system in the composition range between 66 and 85 at.% Be. The internal field and the isomer shift in $FeBe_2$ (66.7% Be, $MgZn_2$ structure) are 192 ± 5 kOe and 0.13 ± 0.05 mm/sec, respectively. A metallic iron standard at room temperature was used. The Moessbauer spectrum of a single crystal of $FeBe_2$ shows that the magnetization is parallel to the c axis. When the Be concentration is increased above 66.7%, two or more internal fields are observed, corresponding to Fe (4), Fe (3), and so on. Fe (4), Fe (3), etc., are defined as Fe atoms which have 4, 3 Fe atoms, respectively, in the nearest-neighbor iron sites. When the Be concentration exceeds 75%, the $MgCu_2$ crystal structure develops and the materials are paramagnetic. The $(Fe-Mn)Be_2$ system was also investigated. It was found that the presence of nearest-neighbor Mn atoms decreases the field at the iron sites by ~14%. (auth)

20058 FIELD-ION MICROSCOPY OF GRAPHITE. Williams, Wendell S. (Univ. of Illinois, Urbana). J. Appl. Phys., 39: 2131-2(Mar. 1968).

Streaks in FIM images from graphite are shown to be transverse to the layer planes. Hence, the streaks are not images of layer-plane edges but distorted point images. Streaking is thus an intrinsic feature of the field-ion microscopy of graphite, resulting from its two-dimensional crystal structure. Therefore, structural studies of graphite by this technique are not feasible with the present methods of sample preparation. (auth)

20059 ELECTRON PARAMAGNETIC RESONANCE IN IRRADIATED GERMANIUM. Horiye, Handy (Gulf General Atomic, Inc., San Diego, Calif.). J. Appl. Phys., 39: 2146-7(Mar. 1968).

The ESR center observed in 30-MeV electron-irradiated n-type germanium is discussed. The germanium was doped with oxygen. (M.O.W.)

20060 BANDGAP DEPENDENCE AND RELATED FEATURES OF RADIATION IONIZATION ENERGIES IN SEMICONDUCTORS. Klein, Claude A. (Raytheon Co., Waltham, Mass.). J. Appl. Phys., 39: 2029-38(Mar. 1968).

The problems dealt with concern the production of electron-hole pairs in a semiconductor exposed to high-energy radiation. The goal is to develop a simple phenomenological model capable of describing the present experimental situation from the standpoint of yield, variance, and bandgap dependence. The premise is that ϵ, the average amount of radiation energy consumed per pair, can be accounted for by a sum of three contributions; the intrinsic bandgap (E_G), optical phonon losses $r(\hbar\omega_R)$, and the residual kinetic energy $(9/5)E_G$. The approach differs from prior treatments in the sense that the residual kinetic energy relates to a threshold for impact ionization taken to be $\frac{3}{2}$ E_G in accordance with indications stemming from studies of avalanching in p–n junctions. This model is subjected to three quantitative tests: (a) Fano-factor variations are found to reflect the relative weight of phonon losses [$K = r(\hbar\omega_R)/E_G$], but residual energy fluctuations govern the statistical behavior for $K^2 \lesssim 0.3$. An application to Ge yields good agreement with the best measurements available (F = 0.13 ± 0.02 at 77°K). (b) The bandgap dependence of pair-creation energies conforms to the model [$\epsilon = (14/5)E_G + r(\hbar\omega_R)$] and suggests that optical phonon losses remain essentially constant [$0.5 \leq r(\hbar\omega_R) \leq 1.0$ eV]. This would imply that the mean-free-path ratio for pair production and phonon emission ($r = \bar{\lambda}_I/\lambda_R$) is of the order of 10 or 20 for most semiconductors. (c) A detailed assessment of the situation in Si leads to the conclusion that, in this material, $\bar{\lambda}_I$ is approximately 400 Å. The figure accords, roughly, with inferences made from the spectral distribution of hot electrons emitted by shallow junctions and thus points to "average" impacts occurring at about 5 eV; by the same token, it substantiates the conception of pairs originating either through plasmon decay or in the final stages of a branching process. (auth)

20061 OPTICAL SPECTROSCOPY OF RARE EARTH PEROVSKITES. Schuchert, H.; Huefner, S.; Faulhaber, R. (Technische Hochschule Darmstadt, Ger.). J. Appl. Phys., 39: 1137-8(Feb. 1, 1968).

High-resolution optical absorption spectra have been obtained on antiferromagnetic $DyAlO_3$ and weakly ferromagnetic $HoFeO_3$ and $DyFeO_3$ at low temperatures. In $DyAlO_3$ the absorption lines show a triplet structure, which vanishes in $Y(Dy)AlO_3$. From this it is concluded that the magnetic interactions take place for each Dy ion with only two neighbors. At 3.5°K the splitting of the absorption lines starts to increase with decreasing temperature yielding a Néel temperature of (3.5 ± 0.1)°K. The magnetic moment of the ground state is determined to be $\mu = (8.6 \pm 1.0)\mu_B$. In $DyFeO_3$ a Néel temperature of (4.5 ± 0.3)°K is deduced from the temperature-dependent lines shift, the magnetic moment of the ground state is found to be $\mu = (8.9 \pm 1.0)\mu_B$. (auth)

20062 NATURAL LINE WIDTHS OF MOESSBAUER ABSORBERS AT VARIABLE LOW TEMPERATURES. Johnson, D. P.; Erickson, G. A.; Dash, J. G. (Univ. of Washington, Seattle). Rev. Sci. Instrum., 39: 420-1(Mar. 1968).

The usefulness of the Mössbauer effect for solid-state studies is often dependent on the availability of continuous temperature control over the source or absorber. A system was developed for clamping which allows one to continuously vary the temperature of resonant absorbers between room temperature and helium temperature while maintaining a natural line width and relatively low heat leaks. The design is based upon the low thermal conductivity of dry solid contacts in high vacuum. In our application, the sample holder is firmly clamped between two stacks of several hundred aluminized Mylar washers. The washers in each stack are loosely threaded together between two nylon washers and have three aluminized Mylar disks interdispersed among the Mylar washers as radiation shields. In addition, a copper washer with four tabs is placed in each of the stacks and anchored to the helium radiation shield. (auth)

20063 MAGNETIC EFFECTS OF RARE-EARTH IMPURITIES ON ELECTRON TRANSPORT IN THE NOBLE METALS. de Vries, G.; Bijvoet, J. (Univ., Amsterdam). J. Appl. Phys., 39: 797-801(Feb. 1, 1968).

Of the dilute alloys of rare-earth metals in the noble metals, only a few show a small resistance anomaly and a temperature-dependent negative magnetoresistance at liquid-helium temperatures. In a saturating magnetic field the decrease for the Gd alloys is 2%. A calculation in Born approximation shows this to be due to interference between Coulomb and spin-dependent scattering. The absolute value of J is found to be 0.04 eV when the interaction is written as $H = -J\delta \cdot S\delta(r - r_i)$. A similar calculation for two different magnetic impurities contains cross terms in the two coupling constants. For Mn in Ag, J is known to be negative from the resistance minimum (Kondo). It is concluded from the fact that, with 0.20 at. % Mn and 0.39 at. % Gd, only a very small magnetoresistance is observed, and that the sign of J is positive. With J = 0.04 eV a small negative Kondo effect can be computed, which is of the same order of magnitude as experimentally found. The magnetic effects in these alloys are small compared to what is reported in the literature on alloys with trivalent solvents. It was checked in a few cases that the magnetic moment agrees with the free-ion values. The explanation of the apparently small value of J probably must be found in a more careful analysis of the interference terms that may be different for different partial waves. (auth)

20064 MAGNETISM IN HIGH MAGNETIC FIELDS. Foner, Simon (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 39: 411-16(Feb. 1, 1968).

A brief summary of several recent high-field studies of magnetism in solids at the National Magnet Laboratory is presented. Topics include high-field superconductors, magnetic phase transitions in simple antiferromagnets, capabilities of high-field Mössbauer measurements for microscopic studies of magnetic structures, rare earth metals, collective electron ferromagnetism, and dilute alloys. (auth)

20065 EFFECTS OF QUADRUPOLE-COUPLING FLUCTUATIONS ON MOESSBAUER SPECTRA OF IONS IN CRYSTALS. Hartmann-Boutron, F. (Faculte des Sciences, Orsay, France). J. Phys. (Paris), 29: 47-56(Jan. 1968). (In French).

Using some simple models, the repercussions on Moessbauer spectra of fluctuations in quadrupole coupling due either to electronic relaxation or to jumps of the surroundings between equivalent Jahn–Teller distortions, or to both simultaneously, are examined. (auth)

20066 MAGNETIC STRUCTURE OF $DyCrO_3$. Bertaut, E. F.; Mareschal, J. (CNRS, Grenoble, France). J. Phys. (Paris), 29: 67-73(Jan. 1968). (In French).

In $DyCrO_3$ (group Pbnm – D_{2h}^{16}), the Cr-spins order at T_{N_1} = 146°K in a G_2-mode. Those of Dy order at T_{N_2} = 2.16°K in a unit cell which has to be doubled in the a and b direction. The irreducible representations of the group Pbnm associated with the wave vector k = [½ ½ 0] are determined. All the 8 irreducible representations are one-dimensional and complex. With the help of the basis vectors $G_x + iA_x$ and $G_y - iA_y$ which describe the non colinear structure, one constructs an effective spin hamiltonian. One finds relations between its coefficients by virtue of the known spin structure. (auth)

20067 BIBLIOGRAPHY OF THIN MAGNETIC FILMS (1963–1967). Chang, H.; Lin, Y. S. (IBM Watson Research Center, Yorktown Heights, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet., MAG-3: 653-700(Dec. 1967).

This bibliography (1963–1967) lists 1300 articles and 170 patents, supplementing an earlier one (1963) which contains 735 articles and 60 patents. (auth)

20068 VARIATION WITH PRESSURE OF MAGNETIC-ORDERING TEMPERATURE OF RARE EARTH SINGLE CRYSTALS. Bartholin, H.; Bloch, D. (CNRS, Grenoble, France). J. Appl. Phys., 39: 889-91(Feb. 1, 1968).

The variation with hydrostatic pressure of the magnetic-ordering temperature of rare earth single crystals has been determined under pressure up to 6 kbar. This effect is determined from the thermal variation of susceptibility in an alternating field. A difference between the variation with pressure of the magnetic-ordering temperature of the polycrystal of Gd and that of the single crystal is observed. The variation with pressure of the Curie temperature of polycrystalline Gd is $(-1.48 \pm 0.02) \times 10^{-3}$ °K bar^{-1} to be compared to $(-1.40 \pm 0.02) \times 10^{-3}$ °K bar^{-1} for the single crystal. The variations with pressure of the Néel temperature of Tb and Dy are, respectively, $(-0.84 \pm 0.02) \times 10^{-3}$ °K bar^{-1} and $(-0.41 \pm 0.01) \times 10^{-3}$ °K bar^{-1}. An attempt to analyze these variations leads to the conclusion that the exchange energy is dependent upon volume for the major part through the c dependence of exchange interactions between first-neighbor ferromagnetic planes. (auth)

20069 STATUS OF MAGNETO-OPTICAL EXPERIMENTS ON ORDERED RARE EARTH COMPOUNDS. Leask, M. J. M. (Oxford Univ.). J. Appl. Phys., 39: 908-14(Feb. 1, 1968).

Rare-earth compounds of interest in this field have ordering temperatures typically in the range 1 to 4°K. This in turn implies internal fields of order 10 kOe, and therefore a potentially amenable experimental situation. A number of such systems have been studied recently, where the magneto-optic effects due to the magnetic order have been studied for both the host rare-earth ion, and for small amounts of order rare-earth ions introduced as probes into the systems. The following are some of the general conclusions to be drawn from this work: (i) the relative success of a "one-ion"—essentially molecular field—picture in explaining effects observed both as a function of temperature and as a function of externally applied field, (ii) the considerable difference between effects seen by host ions and effects seen by probe ions, (iii) observation of magnetic short-range order in the system, and (iv) the considerable difference in detail between short-range-order effects seen in different systems. (auth)

20070 LATTICE VIBRATION OF GRAPHITE. Lee, Tun-chien; Hwang, Jenn-lin (National Taiwan Univ., Taipei). Chin. J. Phys., 5: 134-41(Oct. 1967).

A frequency spectrum of bending vibration of the graphite crystal lattice is calculated by Hwang–Wang's method on the basis of the Born–von Kármán theory of lattice vibration. The elastic constants utilized are $S_0/3 = 2.52 \times 10^3$ dynes/cm for an interaction between atoms of the nearest neighbors in the same plane and S_1 = 20.7 dynes/cm for an interaction between those in the two neighboring different planes. These were determined from the specific heat data. The secular equation solved was determined by Krumhansl and Brooks. The calculated square frequency distribution $g(\omega^2)$ is proportional to the square root of ω^2 in an extremely low-frequency part. Therefore, in the lowest frequency region the frequency distribution $f(\omega)$ shows ω^2-dependence like the Debye's continuum and beyond that it becomes ω-dependence like a two-dimensional lattice as predicted by Rosenstock. Our result is in good conformity with that determined from the neutron scattering experiment of Egelstaff and Cocking and is, naturally, consistent with the specific heat data measured by Hoeven and Keesom. (auth)

20071 EFFECT OF ANNEALING ON INFRARED ABSORPTION OF THE GAMMA-INDUCED SURFACE LAYER ON GERMANIUM. Lee, L.; Lin, K. C. (Union Industrial Research Inst., Hsinchu, Taiwan). Chin. J. Phys. (Taiwan), 5: 63-7(Oct. 1967).

The effect of annealing on the infrared absorption of the ^{60}Co gamma-induced thin layer on the surface of germanium single crystal was studied. Both isochronal and isothermal annealing were using air as the heat-transfer medium. The absorption bands associated with the induced thin layer can be removed under prolonged annealing. But an absorption band with peak at 11.6μ associated with the gamma-induced surface layer on germanium has been observed after isochronal annealing and isothermal annealing at temperature higher than 215°C. The intensity of the 11.6μ band is proportional to the initial annealed temperature. (auth)

20072 NUCLEAR DYNAMIC POLARIZATION BY OPTICAL ELECTRONIC SATURATION AND OPTICAL PUMPING IN SEMICONDUCTORS. Lampel, Georges (Ecole Polytechnique, Paris). Phys. Rev. Lett., 20: 491-3(Mar. 4, 1968).

A nonresonant Overhauser effect by photoexcited conduction electrons is obtained on ^{29}Si nuclei in silicon at 77°K in two different ways: (a) Saturation of the electronic magnetization is achieved with unpolarized light by exciting an equal number of spins up and spins down. (b) Polarized electronic spins are produced by optical pumping with circularly polarized light; the nuclear magnetization obtained in 1 G by optically pumped electrons corresponds to the equilibrium value at 77°K in 28 kG. (auth)

20073 ACHIEVEMENT OF SIGNIFICANT NUCLEAR POLARIZATIONS IN SOLIDS BY OPTICAL PUMPING. Mollenauer, L. F.; Grant, W. B.; Jeffries, C. D. (Univ. of California, Berkeley). Phys. Rev. Lett., 20: 488-90(Mar. 4, 1968). (UCB-34P20-133).

Tm-169 in a crystal of 0.05% Tm^{2+} in CaF_2 was used to demonstrate a previously described [Phys. Rev. Lett., 19: 1221 (1967)] scheme for enhancement of nuclear polarization by optical pumping in solids. A nuclear polarization of 12% was observed. The method of measurement of the electron and nuclear polarizations is described. (A.G.W.)

20074 RECENT RESULTS IN DISPLACEMENT MEASUREMENTS MADE IN THE LABORATORY BY MEANS OF THE MOESSBAUER EFFECT. Richard, Jean Paul (Institut Henri Poincare, Paris). Bol. Univ. Fed. Parana, Fis. Teor., No. 9, 1-12(July 1966). (In Portuguese).

The theory and measurement of the Moessbauer effect are briefly reviewed. The experimental verifications of general relativity using the Moessbauer effect for measurement of the displacement gravitational effect and of the displacement in an acceleration field were reviewed. The review of the experimental results show that the Moessbauer effect makes it possible to measure with excellent precision (~1%) and under very precise experimental conditions the displacement effects predicted by the general relativity. (J.S.R.)

20075 THEORY OF ISOTROPIC AND ANISOTROPIC KNIGHT SHIFTS IN BERYLLIUM. Jena, P.; Mahanti, S. D.; Das, T. P. (Univ. of California, Riverside). Phys. Rev. Lett., 20: 544-6 (Mar. 11, 1968).

Recent experimental measurements of the isotropic Knight shift K_{iso} have led to a negative value of −0.0025(6)%. The small magnitude of the shift has been confirmed by relaxation time measurements in conjunction with the Korringa relation. The anisotropic Knight shift K_{ax} has been found to have an upper limit 0.0003%. This note demonstrates that the small magnitudes of both K_{iso} and K_{ax} may be explained by analysis of the direct and core polarization contributions over the Fermi surface, but the negative sign of K_{iso} requires the inclusion of orbital effects for its explanation. (L.M.T.)

20076 FAST-ELECTRON IRRADIATION EFFECT ON RECOMBINATION RADIATION. Geitsi, I. I.; Nesterov, A. A.; Smirnov, L. S. Fiz. Tekh. Poluprov., 2: 269-70(Feb. 1968). (In Russian).

Recombination radiation spectra and kinetics of cubic modification silicon carbides (β SiC) and effects of irradiation with 3.5-MeV electrons were studied. Specimens of 3 × 3 × 0.5-mm β–SiC monocrystals with specific (n-type) resistance, varying from 10^{-1} to 1 ohm · cm, were irradiated with 3.5-MeV electrons in a microtron-type accelerator at room temperature. X-ray structural analysis of the specimens before and after irradiation did not reveal any changes in the crystal structure. (R.V.J.)

20077 INTERNAL PHOTOEFFECT SPECTRAL DISTRIBUTION IN HEXAGONAL SELENIUM PRODUCED BY UV AND X-RAY EFFECTS. Kolomiets, B. T.; Romanov, V. G.; Khodosevich, P. K. (Leningrad Inst. of Physics and Tech. L'vov Trade and Economics Inst.). Fiz. Tekh. Poluprov., 2: 267-9 (Feb. 1968). (In Russian).

Spectral distribution of the internal photoeffect induced by combined uv- and x-ray excitation was studied in order to determine the energy spectra of the hexagonal selenium forbidden zone. Selenium specimens uradiated with γ ray (continuous spectra,

$h\nu_{eff}$ = 9.8 to 20.8 keV) and 3.96-eV uv were studied at 83°K. Data obtained showed that additional uv irradiation did not affect spectral distribution. The curves of the spectral distribution of the internal photoeffect excited by x radiation exhibited a significant quenching. Kinetics of selenium conductivity during x-ray and photo- irradiation are analyzed. (R.V.J.)

20078 MAGNETIC PROPERTIES OF THE ALLOYS $TbCu_{1-x}Zn_x$. Pierre, Jacques (laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France). Compt. Rend., Ser. A and B, 265: 1169-72(Nov. 20, 1967). (In French).

The magnetic order state of the alloys $TbCu_{1-x}Zn_x$ changes from an antiferromagnetic structure (220) to a ferromagnetic structure when the zinc content is increased. (tr-auth)

20079 MAGNETIC PROPERTIES AND ELECTRON STATE TRANSFERS IN THE SYSTEMS Fe–Be, Co–Be, Ni–Be. Herr, Antoine; Meyer, Andre-J.-P. (Univ., Strasbourg). Compt. Rend., Ser. A and B, 265: 1165-8(Nov. 20, 1967). (In French).

The measurements of the atomic moments of the ferromagnetic alloys of the Fe–Be, Co–Be, and Ni–Be systems show that Be contributes by the 1.4 state to the 3d band in Co and Ni. In Fe–Be, the accumulation of magnetically effective states which are not apparent in the initial solid solution is shown at high concentrations with a number of g states apparently transferred from 0.6 by the Be atom. (tr-auth)

20080 THEORY OF NUCLEAR MAGNETIC TRIPLE RESONANCE SPECTRA IN THE CASE OF WEAK RADIO-FREQUENCY FIELDS. I. Sinivee, V. (Inst. of Cybernetics, Tallin). Izv. Akad. Nauk Est. SSR, Fiz. Mat., 16: 444-57(1967).

It is the purpose of this work to show that signals at combined frequencies must exist in the case of triple resonance. In order to do that, a theory of triple resonance spectra is presented. The following presumptions are assumed to be fulfilled: (1) the system of nuclear spins of the representative molecule (the spin system) consists of identical spins with a positive magnetogyric ratio; (2) the time-dependent part of the Hamiltonian of the spin system has no degenerate eigenvalues and equal differences of eigenvalues; and (3) the three rf fields and the relaxation may be considered as weak. (W.D.M.)

20081 MOESSBAUER QUANTITATIVE ANALYSIS OF Fe^{+3}/Fe^{+2} RATIOS IN SOME PHOSPHATE AND OXIDE MIXTURES: POSSIBILITIES AND LIMITATIONS. Lerman, Abraham (Geological Survey of Israel, Jerusalem. Weizmann Inst. of Science, Rehovoth, Israel); Stiller, Mariana; Hermon, Erica. Earth Planet. Sci. Lett., 3: 409-16(Feb. 1968).

Ratios of the peak areas on Moessbauer spectra of mixtures of vivianite and amorphous ferric phosphate vary linearly with the ratios of the proportions of the phases. This makes it possible to use Moessbauer spectrometry for simple quantitative analysis of ferrous–ferric phosphates. The results of the Moessbauer analysis agree to within 3% of with conventional chemical methods. Interpretation of the Moessbauer spectra of iron phosphate mixtures and oxidized vivianite is consistent with magnetic susceptibility measurements. Consideration of the spectra of a number of ferrous and ferric phosphates and oxides indicates that the Moessbauer analysis may also be applied to some phosphate–oxide mixtures. The slope of the curve of absorption intensities ratio versus proportions ratio deviates from the slope predictable by the theory. Hence, for a reasonably accurate estimation of the Fe^{+3}/Fe^{+2} ratios in mixtures of minerals, calibration curves may need to be constructed for each particular case. (auth)

20082 MOESSBAUER STUDIES OF NICKEL OXIDE: BULK MATERIAL AND ULTRAFINE PARTICLES. Ando, K. J. (Univ. of California, Los Angeles); Kundig, Walter; Constabaris, G.; Linquist, R. H. J. Phys. Chem. Solids, 28: 2291-5(Nov. 1967).

Mössbauer spectra of bulk NiO doped with ^{57}Co show that the ^{57}Fe exists in both the divalent and trivalent state, and that the ratio of their concentrations varies reversibly with temperature. The Fe^{3+} hyperfine field at 0°K is (548 ± 3) kOe and decreases in a normal manner with increasing temperature. The Fe^{3+} hyperfine field shows an anomalous maximum of 210 kOe at 250°K, and decreases to 90 kOe at 0°K. In contrast, ultrafine NiO particles, with an average particle diameter of 103 Å, show only an Fe^{3+} spectrum. The transition from the antiferromagnetic to the superparamagnetic state for the small NiO particles as the temperature is lowered is an example of a slow collapse of the hyperfine field due to relaxation effects. From the observed transition the particle-size distribution and the crystalline-anisotropy constant are estimated. (auth) (UK)

20083 ^{23}Na NUCLEAR MAGNETIC RESONANCE IN FINE POWDERS OF SODIUM CHLORIDE. Hughes, D. G.; Benson, G. C.; Freeman, P. I. (National Research Council, Ottawa). J. Phys. Chem. Solids, 28: 2305-19(Nov. 1967).

The effect of electric quadrupole interactions on the ^{23}Na magnetic resonance was studied at room temperature in a series of NaCl powder samples with specific surface areas ranging from approximately 7 to 70 m^2g^{-1} (average particle size ranging from 4×10^{-5} to 4×10^{-6} cm). First-order quadrupole effects were prominent in each case. The normalized resonance intensity showed a maximum in the vicinity of 18 m^2g^{-1}. This behavior is attributed to perturbations of the lattice associated both with the crystal surface and with dislocations present in the larger particles. Interpretation of the data using the "all or nothing" model, indicates that there is no satellite contribution from ^{23}Na nuclei situated within approximately 80 Å of the crystal surface, and that particles with specific surface area greater than about 7 m^2g^{-1} are predominantly dislocation-free. The electric-field gradient near the free {100} crystal surface was computed using theoretical values of ionic displacement and polarization. In agreement with experiment, the results show that quadrupole interactions associated with the crystal surface are likely to be of long range. The saturation behavior of the ^{23}Na resonance was studied for each sample. The interpretation of this saturation data is discussed, particular attention being paid to cross-relaxation effects. The possibility that a spin–lattice relaxation mechanism associated with the crystal surface may have been detected is considered. (auth) (UK)

20084 NMR MEASUREMENTS OF FIELD GRADIENTS AT Br NUCLEI SURROUNDING A SUBSTITUTIONAL Cl ION IN A KBr CRYSTALS. Andersson, L.-O.; Oedberg, L. (Royal Inst. of Tech., Stockholm). Ark. Fys., 35: 85-99(1968).

The electric field gradient tensors and their orientations related to the crystal axes were determined for the bromine nuclei with the general positions (1,1,0), (2,0,0), and (2,2,0) measured in units of the interionic distance along the crystal axes from a substitutional Cl ion in a KBr crystal. The determination was made from observation of the second-order quadrupole shifts of the ^{79}Br and ^{81}Br nuclear magnetic resonance lines corresponding to transitions between the energy levels with magnetic quantum numbers m = ½ and m = ³/₂. "Critical sphere" measurements, made by observing the decrease in intensity of the unshifted resonance line with increasing chlorine concentration, supported the identification of the nuclei from which shifted lines were observed and gave an estimate of the field gradient at the nuclei with the general position (2,1,1). The field gradient at nuclei more distant from the Cl ion could be estimated by making the critical sphere determination at different frequencies. All results agree fairly well with the prediction by the continuum theory that the field gradient is proportional to the inverse cube of the distance to the point defect. (auth) (Sweden)

20085 FERROMAGNESIAN SILICATE ABUNDANCES IN BRONZITE CHONDRITES AS DETERMINED BY THE MOESSBAUER EFFECT. Sprenkel-Segel, E. L. (Illinois Inst. of Tech., Chicago. Argonne National Lab., Ill.); Perlow, G. J. Icarus, 8: 66-74(Jan. 1968).

The Mössbauer effect in ^{57}Fe was used to investigate iron minerals in meteorites. The ratio of olivine iron to pyroxene iron (calculated from the absorption intensities and the recoilless fractions) was found to be 1.6 ± 0.2 for the bronzite chondrites Collescipoli, Ochansk, and Oakley. The relative amounts of iron in olivine and pyroxene may be combined with the electron-microprobe analyses of iron and magnesium in the separate minerals to obtain the number of formula units of pyroxene relative to olivine in an unseparated meteorite sample. The similar abundance ratios of pyroxene to olivine indicate that these meteorites were derived from a common parent ferromagnesian silicate reservoir. For each meteorite, the FeO content of the olivine-pyroxene system is given as calculated from the MgO content of the chemical analysis, the ratio of magnesium to iron in each silicate, and the relative amounts of iron in olivine and pyroxene. (auth)

20086 THE INFLUENCE OF NEUTRON RADIATION ON CHANGE OF CERTAIN PHYSICAL PARAMETERS OF SEMICONDUCTORS OF THE TYPES Te–Se–Bi AND Te–Sb–Bi. Macko, Pavel (Slovak Inst. of Tech., Bratislava). Fyz. Cas., 17: 51-60(1967). (In Czech).

It is shown that the electrical conductivity can be increased even if the values of lambda, alpha, and Z are relatively invariable. When the thermal neutron flux is limited (by a Cd filter, for example) the radioactivity of samples can be reduced. This is important, since a p-type material will contain Sb. (JPRS)

20087 SPIN-TEMPERATURE MODEL OF NUCLEAR DYNAMIC POLARIZATION USING FREE RADICALS. Borghini, M. (CERN, Geneva). Phys. Rev. Lett., 20: 419-21(Feb. 26, 1968).

A spin-temperature model, valid at low temperature, of nuclear dynamic polarization using electronic spin systems with g-factor anisotropy and hyperfine structure is presented. Predictions for

the maximum polarization corresponding to some free radicals are compared with experiment. (auth)

20088 INVESTIGATION OF ASYMMETRY OF THE QUADRUPOLE SPLITTING COMPONENTS IN MOESSBAUER SPECTRA OF SIDERITE SINGLE CRYSTALS AND POLYCRYSTALS. Gol'danskii, V. I.; Makarov, E. F.; Suzdalev, I. P.; Vinogradov, I. A. (Inst. of Chemical Physics, Moscow). Zh. Eksp. Teor. Fiz., 54: 78-83(Jan. 1968). (In Russian).

Mössbauer absorption spectra of ^{57}Fe in single crystals and polycrystals of siderite ($FeCO_3$) are investigated. The ratio of these two quadrupole splitting intensities in poly- and single-crystal spectra at various angles of orientation of the single crystals with respect to the γ-quantum beam is consistent with the explanation of the integral asymmetry of doublet quadrupole spectra of polycrystals as due to anisotropy of the Debye–Waller factor in the respective single crystals. The signs of the electric field gradient on the iron nucleus in siderite at 300°K (+) and the mean square amplitudes of the iron atom oscillations along the central threefold axis of siderite (2.0×10^{-18} cm^2) or perpendicular to it (4.5×10^{-18} cm^2) are determined. It is demonstrated that the absolute probability of the Mössbauer effect can be estimated as a function of angle on basis of the observed asymmetry of quadrupole splitting of gamma-resonance spectra in single crystals. (auth)

20089 ACTION OF ULTRAVIOLET RADIATION ON A MONOCRYSTAL OF Ba CHLORATE IRRADIATED WITH X RAYS. Fayet, Jean-Claude; Thieblemont, Bernard (CNRS, Essonne, France). Compt. Rend., Ser. A and B, 265: 1343-6(Dec. 6, 1967). (In French).

After irradiation with x rays of a monocrystal of $Ba(ClO_3)_2 \cdot H_2O$ and illumination of the crystal by ultraviolet radiation, the paramagnetic resonance spectrum previously described is profoundly modified. The molecular ion Cl_2^- formed during the ultraviolet irradiation is described. (tr-auth)

20090 RADIATSIONNAYA FIZIKA FERRITOV. (Radiation Physics of Ferrites). Ulmanis, U. A. (ed.). Riga, Izdatel'stvo Zinatne, 1967. 144p.

Data are given on radiation effects in ferrites. Radiation sources, method of studies, and results of experiments carried out in the IRT-2000 nuclear reactor in the Latvian SSR are described. High-frequency properties of irradiated ferrites and radiation effects on electric and magnetic properties of ferrites and magnetic alloys are discussed. 99 references. (R.V.J.)

20091 ADVANCES IN STRUCTURE RESEARCH BY DIFFRACTION METHODS. VOLUME 2. Brill, R.; Mason, R. (eds.). New York, John Wiley and Sons, Inc., 1966. 169p. $9.75.

An earlier article in this series (Vol. 1) described the application of neutron-diffraction techniques to the determination of crystal structures. It was concerned entirely with the scattering of neutrons by the nuclei of atoms. The present article is concerned with the fact that atoms or ions which possess a resultant magnetic moment give rise to additional neutron scattering, additional that is to the scattering which takes place at the nucleus of the atom and which occurs for all atoms. (W.D.M.)

20092 X-RAY DIFFRACTION METHODS. Nuffield, E. W. New York, John Wiley and Sons, Inc., 1966. 421p. $12.50.

A full explanation is given of all pertinent background materials (including the nature, generation, and diffraction of x rays) along with complete descriptions of the five major methods—powder, Lave, rotation–oscillation, Weissenberg, and precession. Detailed instruction in the use of these methods is featured (e.g., the identification of compounds, determination of cell dimensions, etc.). Many tables of basic data and illustrations are included. (W.D.M.)

20093 EXPERIMENTAL MAGNETOCHEMISTRY. NONMETALLIC MAGNETIC MATERIALS. Schieber, Michael M. Series of Monographs on Selected Topics in Solid State Physics. Volume 8. New York, John Wiley and Sons, Inc., 1967. 596p.

Magnetic principles which emphasize paramagnetism and crystal field analysis as well as cooperative phenomena in ordered spin systems are recounted briefly. Methods of preparation of polycrystals and single crystals of magnetic materials are reviewed. Methods of characterization and magnetic measurements with some details about the more recent methods of electron and nuclear resonance, Moessbauer effect and neutron diffraction are covered. An extensive review is included of crystallographic and magnetic data for ferrites, nonferrites, rare earth oxides, and nonoxides such as halides, chalcogenides and other salts of organic or inorganic acids of the transition and rare earth elements. (M.H.R.)

20094 PROGRESS IN NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY. VOLUME 3. Emsley, J. W.; Feeney, J.; Sutcliffe, L. H. (eds.). New York, Pergamon Press, Inc., 1967. 425p. $18.00.

Topics covered are sub-spectral analysis, the isotope shift, nuclear spin relaxation studies of molecules adsorbed on surfaces, relaxation processes in systems of two nonidentical spins, microdynamic behavior of liquids as studied by NMR relaxation times, and solvent effects and nuclear magnetic resonance. (M.H.R.)

20095 RADIATSIONNYE NARUSHENIYA V TVERDYKH TELAKH I ZHIDKOSTYAKH. (Radiation-Induced Defects in Solids and Liquids). Generalova, V. V.; Niyazova, O. R. (eds.). Tashkent, Izdatel'stvo Fan Uzbekskoi SSR, 1967. 156p.

Thirty-two short articles are included on radiation effects on various solids and liquids. The mechanism of radiative destruction of crystals at various radiation energies, radiative diffusion stimulus, and radiative annealing are discussed. Changes induced by radiation in Ge and Si mechanical properties and in their annealing are examined and the products of radiation damage of CdS are investigated. Gamma and alpha radiation effects on $BaTiO_3$ and ruby are studied and radioinduced transformation in seignetto-electric materials are analyzed. Ionization dose distribution of the proton tracks in LiF crystals, thermal conductivity of aromatic and paraffin hydrocarbons in the γ-irradiation field and infrared absorption spectra of glucose radiolysis are discussed. Optimum conditions for bremsstrahlung irradiation and new dosimetric systems and devices are discussed. Data are included on neutron activation analysis of amino acids and the effects of thermal oscillations on the propagation of the chain of subsequent collisions. (R.V.J.)

Theoretical Physics

20096 (TP-210) ASYMPTOTIC FORM OF THE RADIAL DISTRIBUTION FUNCTION IN A FLUID. Hutchinson, P. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1965. 20p. Dep.

It is shown that while the predictions of the Ornstein–Zernike theory concerning the small-angle scattering of radiation by fluids may be correct for a fluid not near its critical point, the related predictions of the asymptotic form of the radial distribution function require an additional condition on the behavior of the scattering function in order that they shall be valid. The behavior of the small-angle scattering as the critical point is approached is discussed. For a case when both sets of predictions are simultaneously valid, numerical calculations are presented to show that the range of the distribution function is strongly influenced by moments of the direct correlation function higher than the second. (auth) (UK)

20097 ENTROPY EXPRESSION OF A FERMI LIQUID IN SHIELDED POTENTIAL APPROXIMATION. APPLICATION TO ^{3}He. Riedel, Eberhard (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Z. Phys., 210: 403-22(1968).

Using the functional representation of the thermodynamical potential, a simple expression for the entropy of a normal Fermi liquid in shielded potential approximation is derived. The result is valid for arbitrary temperatures above a possible phase transition and contains both Fermi (single-particle) and Bose (collective) contributions. It thus represents an improvement over the quasi-particle approximation. When this result is applied to the fluctuation model of liquid ^{3}He, a Bose contribution of the order $T^3 \log T/\Theta$ from spin fluctuations is found as well as the usual quasi-particle term. (auth)

20098 MOTION OF CHARGED PARTICLES IN GROWING OR DECAYING CIRCULARLY POLARIZED WAVES. Sonnerup, B. U. O. (Dartmouth Coll., Hanover, N. H.). Phys. Fluids, 11: 682-3(Mar. 1968).

A constant of motion is derived for a charged particle in the magnetic and electric fields of a circularly polarized wave with time-variable amplitude. The wave is assumed to propagate along a uniform external magnetic field. (auth)

20099 CONSTRUCTION OF THE SPIN FUNCTIONS BY MEANS OF SPINOR INVARIANTS. Gouyet, Jean-Francois (Laboratoire de Physique de l'Ecole Polytechnique, Paris). Compt. Rend., Ser. A and B, 265: 701-4(Nov. 20, 1967). (In French).

Instead of using the representation matrices of the permutation group to obtain the spin wave functions corresponding to different spin multiplicities of a system of N fermions, these functions are constructed beginning with the spinor invariants, indicated by Kramers, following a very simple process. (tr-auth)

20100 ENERGY-MOMENTUM TENSOR FOR ELECTROMAGNETIC FLUIDS. Penfield, Paul Jr.; Haus, Hermann A. (Massachusetts Inst. of Tech., Cambridge). Contract DA-36-039-AMC-

03200(E). pp 407-57 of Recent Advances in Engineering Science, Volume 1. Eringen, A. C. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

From 2nd Technical Meeting of the Society of Engineering Science, East Lansing, Mich. See CONF-641136-(Vol.1).

The force density of electromagnetic origin in polarizable and magnetizable fluids is found through the four-dimensional energy–momentum tensor for the medium. The form of the tensor has been derived from assumptions about the form of the energies and powers, through both Hamilton's principle and the principle of virtual work. Two formulations of electromagnetism of moving media, which are due to Minkowski and Chu, predict identical forces. The resulting energy–momentum tensor and force density are interpreted by means of a model for the Chu formulation. A comparison with previous theories is made. (auth)

20101 DOUBLE-PHOTON CONTRIBUTIONS TO MULTIPLE-PHOTON PROCESSES. II. RESONANCE CASE. Cohan, Norah V. (Univ., Zacatenco, Mexico). Phys. Rev., 166: 1282-6 (Feb. 25, 1968).

A study is made of the contribution to the transition probability of a multiple-photon process for which resonance occurs of the part of the interaction operator quadratic in the vector potential. Only the case is considered in which this vector potential is constant within the region of space to which the system is confined. Under this assumption it is shown that the ratio of the contribution from the quadratic term in the vector potential to that from the linear term is proportional to the square of the energy difference between the initial state of the whole system (material system plus radiation field) and the intermediate state for which resonance occurs. As this energy difference is negligible near resonance, the quadratic term in the vector potential (or double-photon contributions) can be neglected when calculating transition probabilities for multiple-photon processes near resonances in the dipole approximation. (auth)

20102 VARIATIONAL PRINCIPLES FOR EXPECTATIONS. Aranoff, Sanford (Rutgers Univ., Newark, N. J.); Percus, Jerome K. Contract AT(30-1)-1480. Phys. Rev., 166: 1255-62(Feb. 25, 1968).

Variational principles for expectation values of physical quantities other than the energy are derived. The expressions implicitly require Green's-function estimations, and higher-order corrections are available. One principle involves a subsidiary minimization, and the other involves the difference between two quantities which are minimum at the stationary point; consequently, numerical computations can be made with both of these principles. As a simple example, the mean-square radius of the hydrogen atom for an incorrect wave function is corrected, with excellent results. Application is also made to the mean-square radius of a model triton. (auth)

20103 RELATIVISTIC MOTION OF A CHARGED PARTICLE IN THE FIELD OF COINCIDENT POINT ELECTRIC AND MAGNETIC CHARGES. Glikman, L. G. Zh. Tekh. Fiz., 37: 1993-4 (Nov. 1967). (In Russian).

The relativistic motion is described for a particle of charge e and rest mass m in the field of a point electric charge q and a point magnetic charge μ, both located at the origin of coordinates. The equations of motion are written and it is shown that the vector $m(\mathbf{r} \times \dot{\mathbf{r}}) - (e\mu/c)\mathbf{r}/R$ is a first integral of them (here r is the radius vector of the particle and R is the modulus of r). The motion of the particle is confined to a conical surface. The calculation of the trajectory is reduced to a quadrature. (ATD)

20104 LINEAR TRANSPORT THEORY. Case, Kenneth M.; Zweifel, Paul F. Addison-Wesley Series in Nuclear Engineering. Reading, Mass., Addison-Wesley Publishing Co., Inc., 1967. 349p. $17.50.

The purpose of this book is to provide a unified modern treatment of linear transport problems and, in particular, to exhibit the soluble cases. Its unique feature is the presentation of the problems primarily from a single point of view—that of singular eigensolutions. Taking this simple and widely used approach, the text offers applications to neutron diffusion, plasma problems, radiative transfer, and sound propagation. Most of the advanced mathematics needed is developed in the text as simply as possible and in the form needed. Designed primarily as a graduate or advanced-graduate text for courses in neutron transport theory, the book should also be of value to practicing nuclear engineers, astrophysicists, plasma physicists, and applied mathematicians. (auth)

20105 COMMUTATION PROPERTIES OF HILBERT SPACE OPERATORS AND RELATED TOPICS. Putnam, C. R. Ergebnisse der Mathematik und ihrer Grenzgebiete. Band 36. New York, Springer-Verlag New York Inc., 1967. 176p. $7.00.

This monograph considers commuting or "almost" commuting quantities A and B, usually bounded or unbounded operators on a Hilbert space, but occasionally regarded as elements of some normed space. An attempt is made to stress the role of the commutator AB– BA, and to investigate its properties, as well as those of its components A and B when the latter are subject to various restrictions. Some applications of the results obtained are made to quantum mechanics, perturbation theory, Laurent and Toeplitz operators, singular integral transformations, and Jacobi matrices. (W.D.M.)

20106 THE THEORY OF GROUPS. Proceedings of the International Conference held at Canberra, 10–20 August, 1965. Kovacs, L. G.; Neumann, B. H. (eds.). New York, Gordon and Breach Science Publishers, Inc., 1967. 411p. $24.00 Reference Edition, $10.50 Professional Edition. (CONF-650849).

The scientific program of the conference concentrated mainly on non-abelian abstract groups; it consisted of 16 formal lectures, mostly surveys, and 10 informal study groups on special topics, organized informally on an ad hoc basis. (W.D.M.)

20107 PROBLEMS IN GROUP THEORY. Dixon, John D. A Blaisdell Book in Pure and Applied Mathematics. Waltham, Mass., Blaisdell Publishing Co., 1967. 189p.

Problems are given which focus on methods and techniques used in many branches of group theory. Complete solutions are provided to most problems which range from simple examples of groups to important theoretical results. The solutions are accompanied by detailed references. Results on permutation groups, automorphisms, normal series, the factorization of groups, group rings, linear groups, and the theory of linear representations are included. (L.B.S.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 20153.

20108 SEARCH FOR QUARKS IN COSMIC RAYS AT SEA LEVEL. Garmire, G.; Leong, C.; Sreekantan, B. V. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 166: 1280-2(Feb. 25, 1968). (MIT-2098-408).

A search for quarks was conducted at sea level. No events were found with energy losses by ionization in the range 0.06–0.165 and 0.25–0.65 that of singly charged minimum-ionizing particles. The experiment sets an upper limit on the fluxes as 6.6×10^{-11} and 8.8×10^{-11} cm^{-2} sr^{-1} sec^{-1} for $\frac{1}{3}e$ and $\frac{2}{3}e$ minimum-ionizing quarks, respectively. (auth)

Electromagnetic

20109 (NP–17322) PROVERKA KVANTOVOI ELEKTRODINAMIKI V RASSEYANII ELEKTRONOV NA ELEKTRONAKH. (A Check of Quantum Electrodynamics in Electron-Electron Scattering). Budker, G. I.; Kushnirenko, E. A.; Lebedev, R. L.; Naumov, A. A.; Onuchin, A. P.; Popov, S. G.; Sidorov, V. A.; Skrinskii, A. N.; Tumaikin, G. M. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1967. 14p. (In Russian). Dep.

The angular distribution of electron-electron scattering was measured in the counter beam over the angle range 40 to 90° at energy values of 2×43, 2×135 and 2×160 MeV using a system of spark chambers with photographic recording. The results confirm the validity of quantum electrodynamics laws down to distances of 0.5 fermi with 95% confidence. (JPRS)

20110 (SLAC-Trans-79) PHOTOPRODUCTION OF ρ^0-MESONS IN A HYDROGEN BUBBLE CHAMBER AT PHOTON ENERGY LEVELS UP TO 5.8 GeV. Spitzer, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Translated for Stanford Linear Accelerator Center, Calif., from report DESY-F-1/4. 125p. Dep. CFSTI. JCL $10.10 fs, $3.86.

The photoproduction of ρ^0-mesons was investigated at photon energies from threshold up to 5.8 BeV with the help of the 85-cm hydrogen bubble chamber at DESY. About 8400 reactions of the type $\gamma p \rightarrow p\pi^+\pi^-$ were analyzed in 640,000 pictures; ρ^0-production is the dominant process in this reaction above 1.1 BeV. Results on the total cross sections, differential cross sections and decay matrix elements are given for various photon energy intervals. The total cross section rises above threshold to 20 μb and falls slowly to about 16 μb at 5 BeV. The magnitude and the energy dependence of the total cross section are successfully explained by a combined vector-dominance and quark model. The forward differential cross section at 4.5 BeV agrees with the results of Crouch et al., but not with the work of Lanzerotti et al. Both the cross sections and the decay distributions indicate a mainly diffractive production mechanism. At high energies the ρ peak is distorted and shifted to low mass values. These features are explained by the interference of a resonant ρ amplitude with a coherent Drell-type backgroundas proposed by Söding. Several effects of the interference, e.g., a strong variation of the diffraction slope with the invariant $\pi^+\pi^-$ mass near the resonance and a dependence of the ρ mass distribution on the production angle are found. The experimental procedure is described in detail. The results on ρ-production are presented, and a short discussion is given. Also a description of the fitting procedure applied is given. (auth)

20111 ANALYSIS OF THE EXPERIMENTAL DATA OF THE γ-QUANTA COMPTON SCATTERING ON PROTONS AT ENERGIES BELOW 150 MeV. Baranov, P. S.; Sokol, G. A.; Fil'kov, L. V.; Shtarkov, L. N. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 7: 100-4(1968). (In Russian).

All the available experimental data for the elastic γp scattering in the energy region below the one-meson photoproduction threshold are compared with the theoretical results based on the double dispersion relations. The χ^2 test was used. The assembly of the experimental data is coinciding on the 5% level of significance with the theoretical calculations taking into account completely enough the contribution from the annihilation channel and assuming for the π-meson pole the sign identical to the sign of the main part of the amplitude. The agreement is noted of the presented results with conclusions obtained before while analyzing the experimental data in the energy region from 240 to 280 MeV. (auth)

20112 RECOIL-PROTON POLARIZATION IN π^0 PHOTOPRODUCTION. Bloom, E. D.; Heusch, C. A.; Prescott, C. Y.; Rochester, L. S. (California Inst. of Tech., Pasadena). Phys. Rev. Lett., 19: 671-5(Sept. 11, 1967).

The results of an investigation of the energy dependence of the polarization of the final-state proton in neutral meson (π) photoproduction are presented. The energy region covered extends from 750 to 1450 MeV/c incoming photon momentum at π^0 cm angles around 60°. The results of the experiment indicate a zero crossing of the 60° polarization in the energy region covered and a very strong angular dependence. An attempt is made to incorporate this information into a unified description of π^0. (J.F.P.)

20113 PARTICLE YIELDS AT THE STANFORD LINEAR ACCELERATOR CENTER AND THE PHOTON–NUCLEUS INTERACTION IN THE 5 TO 18-GeV REGION. Flatte, Stanley M. (Univ. of California, Berkeley); Murray, Joseph J.; Klein, Paul R.; Johnston, Lawrence H.; Wojcicki, Stanley G. Phys. Rev., 166: 1482-93(Feb. 25, 1968).

Yields of $\pi^\pm$, $K^\pm$, $p^\pm$, and $e^\pm$ at 2 and 3 deg from 16- and 18-GeV electrons on three different targets were measured at the Stanford 2-mile electron accelerator. The targets were: 0.3 radiation length (r.l.) of Be, 0.3 r.l. of Fe, and a combination consisting of 0.6 r.l. of Fe followed by 0.3 r.l. of Be. The yields are discussed in terms of the Drell mechanism (for $\pi^\pm$, $K^\pm$, $p^\pm$), ρ production ($\pi^\pm$), associated production from pions produced by photons (K^+), photodisintegration (p^+), and elastic scattering (e^-). The A dependences of the yields were determined from the ratio of the Be- and the Fe-target yields. (auth)

20114 PHOTOPRODUCTION OF NEUTRAL ρ MESONS. Lanzerotti, L. J.; Blumenthal, R. B.; Ehn, D. C.; Faissler, W. L.; Joseph, P. M.; Pipkin, F. M.; Randolph, J. K.; Russell, J. J.; Stairs, D. G.; Tenenbaum, J. (Harvard Univ.; Cambridge, Mass.). Contract AT(30-1)-2752. Phys. Rev., 166: 1365-78(Feb. 25, 1968).

An experimental study of the photoproduction of charged pion pairs is reported. The pions were detected with two mirror-image magnetic spectrometers, each of which consisted of a half-quadrupole magnet and a number of scintillation counters. The dipion mass spectrum was searched over by fixing the position of the spectrometer arms, fixing the maximum photon energy, and varying the current in each of the half-quadrupole magnets. Measurements were made for symmetrical pairs with opening angles of 18.2° and 32.1° for photon energies of 5.5 and 3.0 BeV and for hydrogen and carbon targets; some measurements were also made with aluminum and copper targets. Measurements were made of asymmetric pairs and symmetrical pairs whose resultant momentum made an angle of 6° with respect to the photon beam. In the course of the experiment, the invariant mass of the dipion system ranged from 0.300 to 1.50 BeV. The only significant structure seen was at the mass of the ρ^0 meson. The measurements showed that the ρ photoproduction from hydrogen is due to a diffractionlike mechanism. The data from complex nuclei showed that the production at 0° was coherent and that the ρ^0's were completely polarized. No evidence was found for a forward-backward asymmetry in the decay of the photoproduced ρ^0's. (auth)

20115 POSITRON–PROTON ELASTIC SCATTERING AT 800 AND 1200 MeV. Anderson, R. L.; Borgia, B.; Cassiday, G. L.; DeWire, J. W.; Ito, A. S.; Loh, E. C. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 166: 1336-42(Feb. 25, 1968).

The cross section for the elastic scattering of positrons from protons was compared with the corresponding electron cross section using secondary beams derived from the photon beam of the Cornell 2-GeV synchrotron. The paths of the scattered leptons (positrons or electrons) and recoil protons were recorded in spark chambers and were used to determine the incident lepton energy of each event. Elastic scatterings were identified by requiring coplanarity and a fit to the scattering kinematics. The detection system was sensitive to scattering angles between 25° and 75°. The ratio of the positron cross section to the corresponding electron cross section was 0.992 ± 0.017 at 800 MeV and 0.987 ± 0.019 at 1200 MeV. No significant variation of the ratio with angle of scattering was found. (auth)

20116 SEARCH FOR FRACTIONALLY CHARGED PARTICLES. Bellamy, E. H.; Hofstadter, R.; Lakin, W. L.; Perl, M. L.; Toner, W. T. (Stanford Univ., Calif.). Contract Nonr 225(67). Phys. Rev., 166: 1391-4(Feb. 25, 1968). (SLAC-PUB-325).

A search was made for fractionally charged particles produced by 12-GeV electrons incident on a copper target. No such particles

were detected. Comparison with calculations on photoproduction of pairs of these particles enables lower limits to be placed on the masses of such particles if they exist. Particles of the type discussed (pure spin-½ Dirac particles with no strong interactions) do not exist with masses below these limits. These limits are dependent on the charge and lifetime assigned to the particle. For lifetimes $\geq 10^{-7}$ sec, the lower limit varies from 0.2 GeV for 0.04e charge, to 1.5 GeV for 0.7e charge. For lifetimes $\geq 10^{-8}$ sec and 0.7e charge, the lower limit is 1.1 GeV. (auth)

20117 ANGULAR DISTRIBUTION FOR ETA-MESON PHOTOPRODUCTION FROM HYDROGEN AT 775 TO 850 MeV. Bacci, C. (Istituto Nazionale di Fisica Nucleare, Rome); Baldini-Celio, R.; Mencuccini, C.; Reale, A.; Spinetti, M.; Zallo, A. Phys. Rev. Lett., 20: 571-4(Mar. 11, 1968).

An experiment performed at a 1.1-GeV electron synchrotron on the photoproduction of the meson (η) from hydrogen in the reaction $\gamma + p \rightarrow \eta + p$ is reported. The forward differential cross section was measured at the energies K = 775, 800, and 850 MeV of the incident photons for different eta cm angles. An investigation was made of the presence, not far from threshold energy, of higher partial waves besides the dominant η–nucleon S-wave resonance. The results show that in the reaction $\gamma + p \rightarrow \eta + p$ up to K = 850 MeV (corresponding to a cm total energy of 1573 MeV) the differential cross section is not sensibly increasing at forward angles. At backward angles a departure from isotropy could start between K = 800 and K = 850 MeV. (J.F.P.)

20118 REFLECTION OF ELECTRONS BY STANDING LIGHT WAVES: EXPERIMENTAL STUDY. Bartell, L. S.; Roskos, R. R.; Thompson, H. Bradford (Ames Lab., Iowa). Phys. Rev., 166: 1494-1504(Feb. 25, 1968).

The reflection of electrons by standing light waves, i.e., the stimulated Compton scattering predicted by Kapitza and Dirac, has been studied experimentally. It has been found that the electron scattering observed in a preliminary study was spurious. Subsequent experiments were performed with greatly improved circuitry and augmented laser intensity. Deflections suffered by 1.6-kV electrons traversing the intense radiation field in the cavity of a giant-pulse laser were measured directly. In many dozens of experiments, electrons were observed to recoil at roughly the expected Bragg angle and with a probability of the predicted order of magnitude. The limited resolving power of the experiment and the uncertainty in the spatial distribution of laser intensity prevented an unequivocal verification of the Kapitza-Dirac theory. It was also found that the electron beam experienced an appreciable field when the laser pulse struck certain parts of the cavity wall. This field took a significant time to develop and sometimes exhibited erratic fluctuations over a period of dozens of microseconds after the laser pulse abated. (auth)

Weak

20119 NEW DETERMINATION OF THE Λ^0 LIFETIME. Grimm, H.-J. (Institut fuer Hochenergiephysik, Heidelberg). Nuovo Cim. (10), 54A: 187-9(Mar. 1, 1968).

For the evaluation of the hyperon (Λ^0) lifetime, hyperons (Λ^0) are used mainly produced in the reaction $K^- + p \rightarrow \Lambda^0 + \pi^+ + \pi^-$, which are well-measured two-prong + V^0 events. The hyperons (Λ^0) were obtained in the hydrogen bubble chamber exposed to a meson (K^-) beam of different moment in the range from 776 to 1200 MeV/c. The reaction channels of 10,315 measured events are listed, and the time distribution for the 8342 Λ^0 decays after cutoffs is shown. The analysis was carried out using two essentially identical methods: maximum likelihood function and Bartlett S-function. The decay rate $\lambda = (0.3953 \pm 0.0054)\ (10)^{10} s^{-1}$ corresponding to a mean life $\tau = (2.535 \pm 0.035)\ (10)^{-10} s$ was obtained. (J.F.P.)

20120 TEST OF THE $\Delta S = \Delta Q$ RULE IN LEPTONIC DECAY OF NEUTRAL K MESONS. Hill, D. G. (Brookhaven National Lab., Upton, N. Y.); Robinson, D. K.; Sakitt, M.; (and others). Phys. Rev. Lett., 19: 668-71(Sept. 11, 1967).

The time distribution of 335 leptonic decays of K^0's produced by $K^+ + d \rightarrow K^0 + p + p$ was analyzed. The likelihood estimate for $xe^{i\varphi}$, the ratio between the $\Delta S = \Delta Q$ violating and nonviolating amplitudes, yields $x = 0.26^{+0.09}_{-0.11}$ and a phase $\varphi = 50^{\circ}{}^{+30}_{-30}{}^{\circ}$. (auth)

20121 MEASUREMENT OF THE MUON DECAY SPECTRUM WITH A WIRE SPARK-CHAMBER SPECTROMETER. Fryberger, David (Univ. of Chicago). Phys. Rev., 166: 1379-91(Feb. 25, 1968).

The decay spectrum of the positive muon was studied in a wire spark-chamber spectrometer of wide momentum acceptance. Both the parameters δ and ρ were determined. On the basis of 4.9×10^5 events, obtained in runs with different fields and targets, the value $\delta = 0.752 \pm 0.009$ was found for the parameter governing the energy dependence of the asymmetry. From a spectrum of 1.7×10^6 events $\rho = 0.762 \pm 0.008$ was found for the shape parameters of the isotropic spectrum (assuming $\eta \equiv 0$), or $\eta = -0.7 \pm 0.5$ (assuming $\rho \equiv \frac{3}{4}$). These values for ρ and δ are in agreement with two-component neutrino theory. Using our value of δ and averages of the most accurate published values of the other muon decay parameters, it is found that the scalar and tensor couplings (in charge retention ordering) can still account for as much as 30% of the interaction. (auth)

20122 DECAY $\Xi^- \rightarrow \Lambda^0 e^- \bar{\nu}$. Hubbard, J. Richard; Berge, J. Peter; Dauber, Philip M. (Univ. of California, Berkeley). Phys. Rev. Lett., 20: 465-8(Feb. 26, 1968).

Two examples of $\Xi^- \rightarrow \Lambda^0 e^- \bar{\nu}$ decay were observed in a study of 2823 Ξ^- production events from a 27-event/μb exposure of the LRL hydrogen bubble chamber to an incident K^- beam at 1.7, 2.1, and 2.40 to 2.75 GeV/c. A branching fraction of 1.0×10^{-3} was obtained for this mode, which is consistent with the Cabibbo theory and with data for other baryon leptonic decays. (L.B.S.)

20123 MEASUREMENT OF THE LOW-ENERGY END OF THE μ^+ DECAY SPECTRUM. Derenzo, S. E.; Hilderbrand, R. H. Univ. of Chicago). Phys. Rev. Lett., 20: 614-16(Mar. 18, 1968).

A beam of stopping μ^+ and π^+ in a hydrogen bubble chamber in a 21-kG field was used to study the parameters η and ρ in the Michel formula (L. Michel, Proc. Phys. Soc. (London) A63, 514 (1950)). In the energy range studied, 1 to 7 MeV, ρ and η are almost decoupled so that a significant two-parameter fit can be made. The distribution of events below 7.4 MeV/c found among 530,000 decays of all momenta, measured values for η and ρ and $\rho - \eta$ correlation are shown. (J.F.P.)

Strong (Baryon-Induced)

Refer also to abstracts 20438, 20442, 20443, 20445, 20446, and 20690.

20124 (JINR-P1-3720) UPRUGOE pHe^4 RASSEYANIE NAZAD PRI ENERGII PROTONOV 665 MeV. (Elastic pHe^4 Backward Scattering at 665 MeV Proton Energy). Komarov, V. I.; Savchenko, O. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 14p. (In Russian). Dep.

The differential cross section of 665-MeV proton elastic scattering by ^{4}He nuclei at an angle of 169° (c.m.s.) was measured by the scintillation counter method. The obtained value $(1.2 \pm 0.3)\ 10^{-31}$ cm^2 ster^{-1} at 9.5 f^{-1} momentum transfer is compared with the theoretical estimation based on the idea of nuclear matter density fluctuations. (auth)

20125 (NP-17315) THE PRODUCTION OF COSMIC GAMMA RAYS IN INTERSTELLAR AND INTERGALACTIC COSMIC-RAY COLLISIONS. III. THE FORM OF THE COSMIC GAMMA-RAY SOURCE SPECTRUM FROM p–p INTERACTIONS FOR GAMMA-RAY ENERGIES LESS THAN 1 GeV. Stecker, F. W. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Dec. 19, 1967. 39p. (SAO-260). Dep. CFSTI.

The cosmic gamma spectrum below 1 GeV arising from p-p interactions is calculated. Its properties are determined by the properties of secondary neutral pion production occurring at accelerator energies. First a detailed discussion of the general properties of the gamma spectra arising from neutral pion decay is given. A determination is made of the various features of such spectra that must, in general, hold true. This discussion includes the results of analytic calculations of normalized gamma spectra from ideal neutral pion energy distributions. An "isobar-plus-fireball" model is then chosen for numerical calculations in which the two dominant modes of neutral pion production at accelerator energies are production of the $N^*_{33}(1237)$ isobar and one fireball. Each of these modes of production then yields a component to the total gamma spectrum. The components are summed and the results are given in terms of integral and differential gamma spectra. A comparison is made with recent balloon data of gamma rays resulting from atmospheric high-energy interactions, and good agreement is found. (auth)

20126 FISSION-LIKE DISINTEGRATIONS OF MEDIUM-MASS NUCLEI INDUCED BY HIGH ENERGY PROTONS. Makowska, E.; Sieminska, J.; Suchorzewska, J. (Univ. of Warsaw, Inst. of Nuclear Research, Warsaw). Acta Phys. Pol., 33: 105-18(Jan. 1968).

An analysis of 788 fission-like interactions of the 25-GeV/c protons with Ag and Br nuclei in low sensitivity emulsion performed. Several possible models which might describe these interactions are analyzed, and a new model is discussed on the assumption that the target nucleus breaks up in an explosion. (auth)

20127 MEAN NUMBER OF SECONDARY NEUTRONS EVAPORATED FROM NUCLEI BOMBARDED BY HIGH ENERGY PRO-

TONS. Vasil'kov, R. G.; Govorkov, B. B.; Gol'danskii, V. I.; Kon'shin, V. A.; Lupandin, O. S.; Matusevich, E. S.; Pimenov, B. A.; Prokhorov, S. S.; Tsypin, S. G. Yadern. Fiz., 7: 88-94 (1968). (In Russian).

The mean number of secondary neutrons ν emitted from various nuclei—from Be up to U—absorbing protons of 400, 500, and 660 MeV is measured by means of the moderation method. At E_p = 660 MeV the number ν varies from 1.5 (Be) up to 16.8 (U) and depends weakly on the energy of the primary protons, especially for light nuclei. Comparison of the numbers ν determined in experiments with the results of calculations (carried out using the Monte-Carlo method) displays a satisfactory agreement, especially in case of heavy nuclei. (auth)

20128 PION, KAON, AND ANTIPROTON PRODUCTION IN THE CENTER-OF-MASS IN HIGH-ENERGY PROTON–PROTON COLLISIONS. Ratner, L. G. (Argonne National Lab., Ill.); Edwards, K. W.; Akerlof, C. W.; Crabb, D. G.; Day, J. L.; Krisch, A. D.; Lin, M. T. Phys. Rev., 166: 1353-64(Feb. 25, 1968).

The differential production cross section $d^2\sigma/d\Omega dP$ has been measured for pions, kaons, and antiprotons produced produced in 12.5-GeV/c proton-proton collisions. In this experiment the dependence of $d^2\sigma/d\Omega dP$ on the longitudinal and transverse components of the c.m. moments of the produced particles, P_l and P_t, was studied while holding all other variables fixed in the center-of-mass system. The ranges of the components measured were P_l = 0.0–1.0 GeV/c and P_t^2 = 0.1–1.5 $(GeV/c)^2$. The 12.5-GeV/c extracted proton beam of the Argonne ZGS impinged upon a liquid-hydrogen target. The produced particles were detected by a spectrometer containing two bending magnets and Cherenkov counters and scintillation counters in coincidence. The incident proton flux was determined by monitor scintillators calibrated during gold-foil irradiations. The cross sections for the production of π^+ and K^+ were all found to have an unambiguous Gaussian dependence on P_t over the entire range. In the formula $d^2\sigma/d\Omega dP = B \exp(-AP_t^2)$, A ≈ 3.5 $(GeV/c)^{-2}$ was found for π^+ and K^-. However, for K^+ A ≈ 2.7 $(GeV/c)^{-2}$ was found. In studying the dependence of $d^2\sigma/d\Omega dP$ on P_l, it was found that the cross section was very strongly peaked about $P_l \approx 0.5$ GeV/c, with very few particles produced near $P_l = 0$. This shows that there is no tendency for particles to be produced at rest in the center-of-mass system. (Such production is predicted by the statistical model.) Instead, particles come out in two clouds or "fireballs" following the two departing baryons. These fireballs have a mass of about 2100 MeV. (auth)

20129 EXPERIMENTAL EVALUATION OF THE ANNIHILATION RADIATION OF ANTIPROTONS AT 3 GeV/c WITH ATOMIC NUCLEI. Montret, Jean-Claude; Devaux, Andre (Faculte des Sciences, Clermont-Ferrand, France). Compt. Rend., Ser. A and B, 265: 1202-4(Nov. 20, 1967). (In French).

The purely experimental study in Ilford G_5 nuclear emulsions exposed to a beam of antiprotons at 3 GeV/c made it possible to determine the ratio between the annihilation radiation and the radiation of the nucleus in which the annihilation radiation is made. (tr-auth)

20130 SPIN CORRELATION PARAMETERS IN p–p SCATTERING AT LOW ENERGY. Catillon, P.; Chapellier, M.; Garreta, D. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). pp 614-16 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Spin correlation parameters A_{xx} and A_{yy} in proton-proton scattering were measured at 11.4, 19.15, 23.45, and 26.5 MeV with a polarized target and a polarized beam. The accuracy is better than 2%. (auth)

20131 NUCLEON–NUCLEON BREMSSTRAHLUNG. Verba, J. W.; Slaus, Ivo; Richardson, J. Reginald; August, Leon S.; Van Oers, W. T. H.; Carlson, R. F. (Univ. of California, Los Angeles). pp 619-23 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The proton-proton bremsstrahlung cross section was measured at E_{inc} = 33.5 and 46 MeV. The experimental data disagree with the present theoretical predictions in both magnitude of the cross section and in its dependence on the incident energy. A direct measurement of the neutron-proton bremsstrahlung cross section has been undertaken. At present only an upper limit of 300 $\mu b/(sr)^2$ can be quoted. (auth)

20132 K^+-MESON PRODUCTION IN p–p COLLISIONS AT 2.5 TO 3.0 GeV. Hogan, W. J.; Piroue, P. A.; Smith, A. J. S. (Princeton Univ., N. J.). Contract N0014-67-A-0151-0001. Phys. Rev., 166: 1472-81(Feb. 25, 1968).

Differential cross sections as a function of momentum are presented for the production of K^+ mesons in p-p collisions at incident proton energies of 2.54, 2.88, and 3.03 GeV. The measurements were made at 20, 30, and 40° relative to the direction of the internal proton beam of the Princeton-Pennsylvania accelerator. At 2.54 GeV, the results follow closely the predictions from phase space (with 60% $K^+\Sigma N$ and 40% $K^+\Lambda p$ in the final state). At 2.88 and 3.03 GeV, however, there is a definite disagreement with phase space. The data are compared to the predictions of three models: (1) a model based on the assumption that K's are produced via $p + p \rightarrow K^+ + X^+$, where X^+ is a B = 2, S = –1 resonance which decays into a nucleon + hyperon; (2) the isobar model; and (3) the one-pion-exchange model. Model (1) is found to be inconclusive, model (2) is inadequate, and model (3) is partly successful in predicting total cross sections, but not in interpreting the detailed experimental observations. (auth)

20133 PRIMARY ENERGY DETERMINATION IN NUCLEON–NUCLEUS COLLISIONS. Bergamasco, Laura; Castagnoli, Carlo. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 42: 395-401(Mar. 1967).

The validity of the main methods for the determination of the Lorentzian factor is checked, and a corrective term is estimated for jets having many black or grey prongs. For this analysis use is made of data from emulsions and bubble chambers. A comparison among the log cotg θ method, the median angle method, and the one based on the constancy of the transverse moment for determining the primary energy is carried out. (J.F.P.)

20134 TWO pn EXPERIMENTS AT 200 MeV: ASYMMETRIES FROM CARBON AND DEUTERIUM, AND A MEASUREMENT OF THE TRIPLE SCATTERING PARAMETER D_t. Spalding, David. Rochester, N. Y., Univ. of Rochester, 1967. 117p.

Thesis.

A double and a triple scattering experiment was performed. The double scattering experiment was performed on targets of deuterium and carbon, using 215 MeV, 85% polarized protons as incident particles. The asymmetry of recoil neutrons was measured at laboratory angles between 10 and 35°, using a neutron counter consisting of a polyethylene converter and multi-element scintillation telescope. The deuterium measurements are related to the free n-p polarization parameter by an impulse approximation calculation. The deuterium results are in good agreement with the predictions of Yale phase shift solutions 3, 3M, 4M, and the new Livermore solution, and are incompatible with Yale solutions 0, 1, 2, 2M. The asymmetries from carbon agree with free n-p scattering except at laboratory angles of 10 and 35°, where they are greater in absolute value. The asymmetry from carbon showed the greatest dependence on neutron energy at these angles. The triple scattering experiment was a measurement of the parameter D_t. The 215 MeV, 85% polarized proton beam was used with a deuterium target. The results were related to the free D_t parameter using an impulse approximation. They are in agreement with the predictions of Yale phase shift solutions 3M and 4M, but are incompatible with the Livermore solution and Yale solution 0, 1, 2, 2M, and 3. The two experiments together are then compatible only with Yale solutions 3M and 4M. The D_t values obtained from deuterium respectively at laboratory angles of 15, 20, and 25° are +0.087 ± 0.068, −0.018 ± 0.071, and +0.058 ± 0.103. (Disser. Abstr.)

Strong (Meson-Induced)

Refer also to abstracts 19155, 20120, and 20122.

20135 (CEA-R-3209) ETUDE DE LA REACTION $\pi^-p \rightarrow \pi^0 n$ A HAUTE ENERGIE (5,9 A 18,2 GeV/c) ET FAIBLE QUADRIMOMENT TRANSFERE. (Study of the reaction $\pi^-p \rightarrow \pi^0$ at High Energies (5.9 to 18.2 GeV/c) and Small Four-Momentum Transfer). Guisan, Olivier (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 70p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

The $\pi^-p \rightarrow \pi^0 n$ reaction was studied by means of α heavy-plate spark chamber which detected the two photons from the π^0 decay. The methods used for the analysis are presented. In particular it is shown that the obtained events are not contaminated by inelastic processes. The differential cross sections show a pronounced diffraction peak. Its values at 0° are compared, with dispension relation predictions. Among the envisaged theoretical models, the Regge formalism gives a specially good fit to the obtained results. (auth)

20136 (COO–1195-110) SPIN-PARITY ANALYSIS OF THE B MESON. Mortara, D.; Ascoli, G.; Crawley, H. B.; Shapiro, A.

(Illinois Univ., Urbana. Dept. of Physics). Jan. 1968. Contract AT(11-1)-1195. 7p. (CONF-671122-4). Dep. CFSTI.

From 3rd Topical Conference on Resonant Particles, Athens, Ohio.

A study of the $\omega^0\pi^-p$ final state produced by 5-GeV/c mesons (π^-) in a hydrogen bubble chamber is reported. The sample consists of 1571 events which fit the reaction $\pi^- + p \rightarrow \pi^- + p + \pi^+ + \pi^- + \pi^0$. The most prominent feature of this reaction is the production of the meson (B) which can be seen from the $\omega\pi$ mass spectrum. The spin and parity are calculated for the meson (B). (J.F.P.)

20137 (COO-1195-116) THE REACTIONS $K^-p \rightarrow \Sigma^\pm\pi^\mp$, $\Sigma^\pm\pi^\mp\pi^+\pi^-$, AND $\Sigma^\pm\pi^\mp K^+K^-$ AT 4.1 GeV/c AND 5.5 GeV/c. Loos, James Stavert (Illinois Univ., Urbana). Feb. 1968. Contract AT(11-1)-1195. 226p. Dep. CFSTI.

Thesis.

The data presented and discussed were obtained from K^-p interactions at 4.1 GeV/c and 5.5 GeV/c in the MURA thirty-inch hydrogen bubble chamber. Meson (K^-) track lengths equivalent to 0.95 μb per event and 0.27 μb per event were analyzed at 4.1 GeV/c and 5.5 GeV/c, respectively. Differential cross sections are given for the $\Sigma^\pm\pi^\mp$ final states, and the results obtained agree well with extrapolated results from lower energies. The data for $\Sigma^+\Sigma^-$ is interpreted in terms of the Regge pole model. A search for the existence of hyperon resonances in the mass region above 1900 MeV/c^2 is made in the $\Sigma^\pm\pi^\mp\pi^+\pi^-$ data, but no evidence for such resonances is found. Consistent with results from lower energies, this reaction appears to be dominated by quasi-three-body processes in which either the Y_0^* (1405), Y_0^* (1520), or ρ(770) is produced. Cross sections and production angular distributions for the various resonance productions are given. Production of Y_0^* (1405), Y_0^* (1520), and ϕ(1020) are observed in the $\Sigma^\pm\pi^\mp K^+K^-$ data. Cross sections and production angular distributions are given for the observed resonant processes. A measurement of the mass and width of the ϕ(1020) yields a mass of 1020.8 ± 1.0 MeV/c^2 and a width of $1.7^{+1.3}_{-1.3}$ MeV/c^2. (auth)

20138 (UCRL-18001) PION-PROTON ELASTIC SCATTERING: LOW ENERGY EXPERIMENTS AND PHASE SHIFT ANALYSES. Johnson, Claiborne; Steiner, Herbert (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1967. Contract W-7405-eng-48. 41p. (CONF-671203-5). Dep. CFSTI.

From Conference on πN Scattering, Irvine, Calif.

The status of π p elastic scattering experiments below p_π = 2 GeV/c is briefly reviewed. Then the phase shift analysis is discussed including the methods used, results obtained, and some of the problems encountered. (J.F.P.)

20139 STUDY OF $Y_1^*(1660)$ AND $Y_1^*(1695)$ PRODUCTION IN K^-p INTERACTIONS. Primer, M. (Syracuse Univ., N. Y.); Goldberg, M.; Jaeger, K.; Barnes, V.; Dornan, P.; Skillicorn, I.; Leitner, Jack. (Phys. Rev. Lett., 20: 610-14(Mar. 18, 1968). (BNL-12131).

Information on I = 1 hyperon resonances in the mass range 1600 to 1750 MeV, made in K^-p reactions at 4.6 to 5.0 GeV/c is reported. Significant Σ(1660) production is noted, primarily in the $\Sigma^0\pi^+$ and $(\Sigma\pi\pi)^+$ states. Branching ratio estimates are given. Evidence is presented which strongly supports the existence of a new Y_1^* at 1700 MeV in the $\Lambda\pi^+$ system, which was reported previously. There are no unambiguous indications of other decay modes. A compilation of high-energy experiments yields the values M = 1695 ± 8 MeV, Γ = 108 ± 20 MeV for the new Y_1^*. (J.F.P.)

20140 Ω^- PRODUCTION BY 6 GeV/c K^- MESONS. Scotter, D. (Birmingham Univ., Eng.); Erskine, R.; Hughes, I. S.; Paler, K.; Sisterston, L. K.; Gandini, F.; Ochs, W.; Allison, J. Phys. Lett., 26B: 474-6(Mar. 4, 1968).

The discovery of nine examples of Ω^- production by K^- mesons at 6 GeV/c is reported and a value is deduced for the mass of the Ω^- together with estimates of the production cross section and lifetime. (auth)

20141 PRODUCTION AND DECAY OF THE ρ^- MESON IN THE REACTION $\pi^-p \rightarrow \pi^-\pi^0p$ AT 2.77 GeV/c. Baton, J. P.; Laurens, G. (CEN, Saclay, France). Phys. Lett., 26B: 471-3(Mar. 4, 1968).

Results are given on the ρ^- mass and width. The dipion production angular distribution is studied as a function of the dipion mass. The behavior of the ρ_{00} density matrix element is also discussed. (auth)

20142 FURTHER EVIDENCE FOR BARYON EXCHANGE FROM K^+p BACKWARD ELASTIC SCATTERING. Cline, D.; Moore, C.; Reeder, D. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 19: 675-8(Sept. 11, 1967).

The K^+p elastic scattering near the backward direction was studied at a beam momentum of 3.5 GeV/c. In addition to providing evidence for baryon exchange, the experimental results show a possible turnover of the angular distribution for positive values of u which is interpreted in terms of a Reggeized baryon exchange model. A comparison of K^+p, π^+p, and π^-p backward scattering was made within the framework of SU(3) which leads to predictions concerning other, as yet unmeasured, K^+N processes. (auth)

20143 QUASI-TWO-BODY FINAL STATES PRODUCED IN π^+p INTERACTIONS BETWEEN 3 AND 4 GeV/c. Brown, David (Univ. of California, Berkeley); Gidal, George; Birge, Robert W.; Bacastow, Robert; Fung, Sun Yiu; Jackson, Warren; Pu, Robert. Phys. Rev. Lett., 19: 664-7(Sept. 11, 1967).

Cross sections and angular distributions for the quasi-two-body final states $N^{*++}\rho^0$, $N^{*++}\omega^0$, and $N^{*++}\eta^0$ were measured at five incident π^+ momenta between 3 and 4 GeV/c. These cross sections, when combined with results at higher momenta, indicate that the momentum dependence of the $N^{*++}\rho^0$ cross section deviates from that expected for a meson-exchange reaction, and that there is shrinking of the diffraction peak. Dips in the production angular distributions are observed, similar to those observed in two-body final states. (auth)

20144 NEW STRUCTURES IN THE K^-p AND K^-d TOTAL CROSS SECTIONS BETWEEN 2.4 AND 3.3 GeV/c. Abrams, R. J.; Cool, R. L.; Giacomelli, G.; Kycia, T. F.; Leontic, B. A.; Li, K. K.; Michael, D. N. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 19: 678-80(Sept. 11, 1967).

Small structures observed in K^-p and K^-d total cross section measurements are interpreted as indications for two new I = 1 resonances at c.m. energies of 2455 ± 10 and 2595 ± 10 MeV. (auth)

20145 FOUR- AND FIVE-BODY FINAL STATES FROM 3-GeV/c π^-p INTERACTIONS. Key, A. W. (Univ. of Toronto); Prentice, J. D.; Steenberg, N. R.; West, E.; Yoon, T. S.; Cooper, W. A.; Manner, W.; Voyvodic, L.; Walker, W. D. Phys. Rev., 166: 1430-47(Feb. 25, 1968).

Approximately 3600 four-prong events produced by π^-p interactions at 2.96 GeV/c were analyzed. The $p\pi^+\pi^-\pi^-$ channel shows production of $\underline{N}^{*++}(1238)[(41 \pm 4)\%]$, $\rho^0[(40 \pm 5)\%]$, and $A_2^-[(7 \pm 2)\%]$. Some evidence for associated $\underline{N}^{*0}\rho^0$ production is also observed. The one-pion-exchange mode with form factor is shown to give an adequate description of the $\underline{N}^{*++}\rho^0$ events. The $\underline{N}^{*++}\pi^-\pi^-$ events are analyzed within the framework of this model, and the I = $2\pi\pi$ scattering cross section up to $m(\pi\pi) \simeq 1$ GeV/c^2 is calculated. A value for the I = $2\pi\pi$ s-wave scattering length of $|\alpha_0^0| = 0.19 m_\pi^{-1}$ is obtained. In a determination of the spin and parity of the A_2 meson, the 2^+ assignment is favored throughout the fairly wide range of experimental uncertainties in the estimate of the background in the A_2 region. The $p\pi^+\pi^-\pi^-\pi^0$ channel is dominated by production of $\omega^0[(26 \pm 2)\%]$, and $\underline{N}^{*++}(1238)[(30 \pm 6)\%]$. ρ^-, ρ^0, and $\underline{N}^{*+}(1238)$ are produced much more weakly. Peripherality is much less pronounced than in the four-constraint fits. No B meson is observed in the present data. The observation of enhancements at 2080 and 2190 MeV/c^2 in the $p\pi^+\pi^-\pi^0$ spectrum has been reported previously. The $n\pi^+\pi^+\pi^-\pi$ channel shows strong $\underline{N}^{*-}(1238)$ production [(50 ± 10)%] and some weak ρ^0 production. (auth)

20146 SCATTERING OF π^- MESONS IN THE MOMENTUM RANGE 875 TO 1579 MeV/c FROM A POLARIZED PROTON TARGET. Duke, P. J. (Rutherford High Energy Lab., Chilton, Eng.); Jones, D. P.; Kemp, M. A. R.; Murphy, P. G.; Tresher, J. J.; Atkinson, H. H.; Cox, C. R.; Heard, K. S.; Phys. Rev., 166: 1448-57(Feb. 25, 1968).

Measurements were made of the asymmetry in the scattering of π^- mesons by a polarized proton target. Scattered π mesons and recoil protons were detected in arrays of scintillation counters; data were obtained at 16 scattering angles at each of 8 beam momenta between 875 and 1578 MeV/c. Analysis of these data together with earlier differential-cross-section measurements shows that there must exist at least three resonances in this energy region: (i) mass 1920 MeV/c^2, Γ = 170 MeV/c^2, I = $\frac{3}{2}$, $F_{\frac{5}{2}}$; (ii) mass 1682 MeV/c^2, Γ = 100 MeV/c^2, I = $\frac{1}{2}$, $F_{\frac{5}{2}}$; and (iii) mass 1674 MeV/c^2, Γ = 100 MeV/c^2, I = $\frac{1}{2}$, $D_{\frac{5}{2}}$. (auth)

20147 OBSERVATION OF A $p\bar{p}$(3755) ENHANCEMENT IN THE REACTION $\pi^+p \rightarrow \pi^+p\bar{p}p$ AT 8.4 BeV/c. Ehrlich, R.; Piano, R. J.; Whittaker, J. B. (Rutgers-The State Univ., New Brunswick N. J.). Phys. Rev. Lett., 20: 686-8(Mar. 25, 1968).

The observation of a narrow enhancement in the $p\bar{p}$ invariant-mass spectrum is reported from a systematic study of $\pi^+ + p$ interactions at 8.45 BeV/c in a 6500-picture exposure of the BNL hydrogen bubble chamber. Twenty-one events of the type $\pi^+p \rightarrow \pi^+p\bar{p}p$ were observed from a sample of ~15000 four-prong events. Monte Carlo calculations favored the interpretation of the enhancement as the $p\bar{p}$ decay of a nucleon isobar, with M = 3755 ± 8 MeV and Γ = 40 ± 20 MeV. (L.B.S.)

20148 PROPERTIES OF K*(890) AND K*(1400) PRODUCED IN K⁻p INTERACTIONS AT 4.1 AND 5.5 GeV/c. Schweingruber, F. (Argonne National Lab., Ill. Northwestern Univ., Evanston, Ill.); Derrick, M.; Fields, T.; (and others). Phys. Rev., 166: 1317-36 (Feb. 25, 1968).

An analysis was made of K⁻p interactions in the 30-in. hydrogen bubble chamber at the Argonne ZGS using incident K⁻ beams of momenta 4.1 and 5.5 GeV/c. The K̄πN final states were studied extensively; the most prominent feature of these is production of the K*(890) and K*(1400) resonances. The $\bar{K}^0\pi^-\pi^+n$ final state was used to measure the branching ratio of the decay of the K*(1400) into K*(890)π and Kρ. Evidence for quasi-two-body production of K*(890)⁻ and K*(1400)⁻ is presented both from the two-prong events in which the positive track was identified as a proton, and from events where the $\bar{K}^0$ decay was observed. For final states with a missing neutron, a study of the missing-mass distributions proved that the kinematical fits to $K^-\pi^+n$ and $\bar{K}^0\pi^-\pi^+n$ final states could be used with confidence to study K*(890)⁰ and K*(1400)⁰ production. The K*(890)⁰,⁻ production angular distribution and decay correlations are analyzed in the framework of the absorptive peripheral model. Vector exchange dominates the K*(890)⁻ production, whereas K*(890)⁰ is formed mainly via pseudoscalar exchange. An absorptive-peripheral-model calculation using the vector-meson coupling strengths to the nucleon given by relativistic SU(6) gives a good fit to the K*(890)⁰,⁻ density-matrix elements as a function of production angle, and gives a reasonable fit to the differential cross section. For the K*(1400) resonance, a mass and width of 1416 ± 8 and 107 ± 20 MeV are obtained. Decay branching ratios measured for this resonance of Kπ : K*π : Kρ of 1 : (0.52 ± 0.12) : (0.26 ± 0.16) are in agreement with those predicted from SU(3) assuming the K*(1400) is a member of a 2⁺ nonet. The absorptive peripheral model gives no reasonable fits to the K*(1400) production angular distributions. The K*(1400)⁰,⁻ production and decay angular distributions suggest that the spin parity of the K*(1400) is 2⁺, but without many more events, or a better model for the production mechanism, a decisive determination can not be made. (auth)

20149 STUDY OF $\pi^-p \rightarrow \omega n, \phi n$ AT 2.10 BeV/c. Boyd, J. H.; Erwin, A. R.; Walker, W. D.; West, E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 166: 1458-72(Feb. 25, 1968). (COO-881-120).

In a bubble-chamber experiment at 2.10 BeV/c the cross section $\sigma(\pi^-p \rightarrow \omega n) = 1.41 \pm 0.18$ mb was determined by fitting the neutral and the charged effective-mass spectra for events of the type $\pi^-p \rightarrow \pi^+\pi^-n(m)\pi^0$, m ≥ 1, with appropriate phase-space and resonance effective-mass distributions. Cross sections for other contributing reactions are also given. The cross section $(\pi^-p \rightarrow \phi n) = 19^{+4}_{-3}$ μb (statistical error) was obtained by using the maximum-likelihood method to determine the cross section corresponding to a peak (at the φ mass 1019.5 MeV) in the K^+K^- effective-mass spectrum of K^+K^-n events. The relative probability of the cross section being zero is 0.07. It is concluded that $\sigma(\pi^-p \rightarrow K^+K^-n)$ is between 75 and 150 μb at 2.10 BeV/c. The K-pair events studied include events both with and without a visible K decay. The nondecay-event identification procedure included a visual bubble-density estimation. An ω-φ mixing angle of 42.1 ± 1.8° (statistical error) was calculated using a quark-model prediction by Alexander, Lipkin, and Scheck. This mixing-angle prediction agrees well with values calculated from SU(3) mass formulas. The input data for this calculation are our φn cross section (at c.m. energy 2.20 BeV) and the ωn cross section at c.m. energy 1.96 BeV which we estimated from $\pi^+n \rightarrow \omega p$ data. (auth)

20150 PERIPHERAL DIPION PRODUCTION BY PIONS OF 12 AND 18 GeV/c. Jones, Lawrence W.; Bleuler, E.; Caldwell, D. O.; Elsner, B.; Harting, D.; Middelkoop, W. C.; Zacharov, B. (CERN, Geneva). Contract Nonr 1224(23). Phys. Rev., 166: 1405-30(Feb. 25, 1968).

A spark-chamber experiment on the peripheral production of 9245 pion pairs by 12- and 18-GeV/c incident pions is reported and analyzed in terms of a one-pion-exchange model in which the final state at the nucleon vertex contains generally one or more pions. The relevant dynamics and kinematics appropriate to this problem are reviewed, and the experimental and analysis techniques giving good resolution and detection-bias correction are discussed in some detail. From the results, fair agreement is found between the data and the one-pion-exchange calculation of the ρ^0 production cross sections and of the associated missing-mass spectra. The ρ^0 is found to be consistent with a single peak, and no evidence of peak splitting is observed. A search for a narrow s-wave dipion resonance is made with negative results. Normalizing to the ρ^0 meson, the s-wave $\pi^+\pi^-$ scattering cross section is computed from the abundant low-dipion-mass events, giving a cross section falling smoothly from 50 mb (300 MeV) to about 20 mb (600 MeV). No evidence of an s-wave resonance is found in this range of energies. Below 450 MeV, the pion-pion scattering asymmetry favors backward scattering (by $2\frac{1}{2}$ standard deviations), which is consistent with a negative and falling J = T = 0 phase shift. The extrapolated forward-backward asymmetry and the s-wave cross section are both consistent with a J = T = 0 phase shift near |90°| at about 750 MeV. (auth)

20151 RESONANCES PRODUCED IN THE REACTION $\pi^-p \rightarrow \pi^-\pi^-\pi^+p$ AT 8 GeV/c. Lamsa, J. W.; Cason, N. M.; Biswas, N. N.; Derado, I.; Groves, T. H.; Kenney, V. P.; Poirier, J. A.; Shephard, W. D. (Univ. of Notre Dame, Ind.). Phys. Rev., 166: 1395-1404 (Feb. 25, 1968).

A study was made of the reaction $\pi^-p \rightarrow \pi^-\pi^-\pi^+p$ at an incident momentum of 8.05 GeV/c. This reaction is found to be very peripheral and dominated by production of the ρ^0 and the N^{*++} (1236). The A_2 meson and an additional $\pi^-\rho^0$ enhancement at 1190 MeV are observed. The spins and parities of these resonances are examined with particular attention to the effect of the type and amount of background assumed. There has been much interest in higher-mass boson resonances; an enhancement in the 3π mass distribution at 1610 MeV is examined which appears to decay primarily to π^-f^0. An enhancement in the $\pi^-\pi^+p$ system near 1400 MeV is observed. It is found that this enhancement cannot be explained by a Deck-type production mechanism, and it is concluded that the enhancement is due to production of the Roper resonance, the N* (1400). (auth)

20152 $\pi^\pm p$ BACKWARD SCATTERING BETWEEN 1.5 AND 3.0 BeV/c. Carroll, A. S. (Brookhaven National Lab., Upton, N. Y.); Fischer, J.; Lundby, A.; Phillips, R. H.; Wang, C. L.; Lobkowicz, F.; Melissinos, A. C.; Nagashima, Y.; Tewksbury, S. Phys. Rev. Lett., 20: 607-9(Mar. 18, 1968).

Measurements of the elastic scattering of mesons (π^+) and (π^-) from protons in the backward direction are reported. The momentum range covered was from 1.48 to 2.93 GeV/c. The cross sections are presented for each interaction from data consisting of 500 to 1000 events for each distribution. (J.F.P.)

Particle Interactions and Properties (Theoretical)

General

20153 (AED-C-23-22) HIGH ENERGY PHYSICS INDEX. Volume 6, No. 1 (1-396). (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1968. 155p. Dep.

A monthly report of material received at DESY is presented. This material covers experimental and theoretical high-energy physics and includes the various particle interactions, strange particles, accelerators, methods and instruments, symmetry principles, and field theory. An author index and a report number index are also given. (J.F.P.)

20154 (INP-555/PH) PROCEEDINGS OF THE VII CRACOW SCHOOL OF THEORETICAL PHYSICS. Volume I. (Institute of Nuclear Physics, Krakow (Poland)). June 1967. 222p. Dep.

There were 14 lectures included. Separate abstracts were prepared for each lecture. (J.F.P.)

For abstracts of individual papers see: 19735, 20155–20158, 20211, 20212, 20222, 20281, 20302, 20310, and 20336–20338.

20155 (INP-555/PH, pp 5-42) ALGEBRA TOKOV. (Current Algebra). Ioffe, B. L. (In Russian).

In the theory of elementary particles, current algebra assumes the existence of cummutative relations between field operators in their canonical form, and the possibility of passing from a Heisenburg presentation to an interaction presentation. These commutative relations should not in general take place in nonlocal theories, and therefore, an experimental confirmation of the results of current algebra makes it possible to explain which of the various classes of initiating Lagrangians in strong interactions occur in nature. Since the relations are exact and a number of the relations depend on the assumed model, it should be possible to predict the real model or which of the particles are fundamental ones. The explanation of the structure of weak interactions at high energies can be significantly advanced by applying current algebra to the physics of weak interactions with the participation of hadrons. The commutative relations between components of the vector and axial hadron fluxes (with and without a change in strangeness) are examined for a number of actual physical systems. The methods of expressing observable quantities by simultaneous commutative flux operators are presented. The role of Swinger terms is

discussed. The flux algebras are applied to determining the total cross-section of the process $e^+ + e^- \rightarrow$ hadrons at high energies. The problem of neutral fluxes in hadron-lepton interactions is considered from the viewpoint of the theory of weak interaction with an intermediate W-boson. (TTT)

20156 (INP-555/PH, pp 93-8) MOESSBAUER EFFECT AND ELEMENTARY LENGTH. Kirzhnits, D. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki).

The present state of the problem of elementary length is briefly reviewed, and new results are given. The use of the Mössbauer effect technique for the determination of this length is described. (J.F.P.)

20157 (INP-555/PH, pp 121-39) BIPERIPHERAL MODEL. Bialkowski, G. (Warsaw Univ. (Poland). Inst. of Theoretical Physics).

An attempt is made to show how one can try to understand the main features of the processes of the type $2 \rightarrow 3$ particles, using the model with three vertices joined by two internal lines, called the biperipheral model. The biperipheral model is understood as a description of the physical situation, where the incoming particle a excites the structure of the target particle b (if the particle a is not structureless then its own structure can be excited as well) and the excitation is so large that it is not very probably evaporated in a single emission act. In that case the excitation travels through the cloud of particle b until it is evaporated in the second act. (J.F.P.)

20158 (INP-555/PH, pp 155-70) DECAY LAWS FOR UNSTABLE PARTICLES. Lukierski, Jerzy (Wroclaw Univ. (Poland). Inst. of Theoretical Physics).

A description of the simplest unstable systems with emphasis on their decay laws is investigated. The unstable state in nonrelativistic and relativistic theory is discussed. The unstable states as superpositions of stable states, with definite energy, characterized by a density matrix diagonal in the energy operator, and the superposition of stable states characterized by a definite value of the mass parameter are introduced. The definition of covariant elementary unstable systems by means of the singularities of the propagator analytically continued into the unphysical sheet is discussed. The possibility is considered of introducing an operator formulation of an unstable particle field, satisfying the requirements of Lorentz invariance, and the shortcomings of the operator approach are briefly listed. (J.F.P.)

20159 (JINR-E2-3729) SOME EXPERIMENTAL CONSEQUENCES OF THE ANALYTICITY OF THE FORMFACTOR. Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 9p. Dep.

On the basis of the analyticity of the form factor the connection between its behavior in the physical regions of the scattering and annihilation channels are studied. Also some lower bound for the form factor in the annihilation channel is established. (auth)

20160 THEORY OF THE STRUCTURE OF ELEMENTARY PARTICLES AND ITS APPLICATION TO THE CALCULATION OF THEIR DECAY ENERGY. Akulov, N. S. (Lab. of Physical Problems, Minsk). Dokl. Akad. Nauk BSSR, 11: 492-7(1967). (In Russian).

It was concluded recently that matter consists of fundamental particles, designated as "rheons." The properties of these particles depend on their quantum state, determined by their quantum number such as spin, charge, gravitational excitation and strangeness. New results are arrived at by comparing the findings of this theory with the conclusions derived from the Nagoya model. At velocities close to the speed of light, the kinetic mass of the electron assumes increasingly larger values. Changes of the quantum number of orbital moments depend on the emission or absorption of neutrinos; therefore, the absorbed neutrinos must be considered as quasiparticles in the structure of positrons. Calculation of the mass of rheons requires quantification of the mass of charged particles in motion. The calculated values agree with experimental data and allow one to calculate the mass of elementary particles. (TTT)

20161 DISSIPATIVE PROCESSES, QUANTUM STATES, AND ENTROPY. Prigogine, I.; Henin, F.; George, Cl. (Univ. Libre, Brussels). Proc. Nat. Acad. Sci. U. S., 59: 7-14(Jan. 1968).

The meaning of quantum state corresponding to a finite lifetime, the possibility of associating a well-defined energy with such a state, and the relation of a physical particle with finite time to field theoretical concepts are briefly discussed. A partial answer is formulated in the frame of perturbation theory and starting from the von Neumann equation for the density matrix. (J.F.P.)

20162 CURRENT-ALGEBRA SUM RULES AND ASYMPTOTIC BEHAVIOUR. Sartori, G.; Tonin, M. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim. (10), 54A: 55-66(Mar. 1, 1968).

A new method is proposed to derive covariant sum rules from current algebra. This method allows one to discuss easily the convergence properties of the sum rules and the limiting procedure required to obtain them. (auth)

20163 WAVE-FUNCTION RENORMALIZATION AND THE BOOTSTRAP CONDITION. Alexanian, M. (Univ. of California, Livermore). Contract W-7405-eng-48. Nuovo Cim. (10), 54A: 184-6(Mar. 1, 1968).

The problem of how to define a bootstrap theory in the context of a Lagrangian field theory with finite mass renormalization is discussed. One particular case considered is when the propagator for the elementary particle has two poles located at μ^2 and $\bar{\mu}^2$ and a zero at s_B. Requiring $\mu^2 = \bar{\mu}^2$ forced vertex renormalization constant of the particle at mass μ to vanish and in order to make this theory agree with a bootstrap theory it was assumed that the particle's wave function renormalization constant Z_3 must vanish. It is shown that in general Z_3 cannot vanish in this limit in fact $Z_3 = \frac{1}{2}$. (J.F.P.)

20164 VECTOR-PARAMETER AND THE COVARIANT THEORY OF SPIN. Fedorov, F. I.; Tkharev, E. E. Yadern. Fiz., 7: 189-91(1968). (In Russian).

On the basis of the complex vector parametrization of the Lorentz group a general covariant expression for the spin operator of a particle with arbitrary momentum is obtained. In case of nonzero mass the operator is constructed that transforms the spin state of a moving particle with any spin at fixed momentum. (auth)

20165 FUTURE OF ELEMENTARY PARTICLE RESEARCH. Weisskopf, Victor F. Arbeitsgemeinsch. Forsch. Landes Nordrhein-Westfalen, No. 153, 7-31(Nov. 4, 1964). (In German).

The development of the concept of subatomic particles is traced from the atom to the mesons and nucleons. The roles of the quantum theory and of the concept of symmetry are discussed, the significance of the research into subatomic particles for the physics is stressed. (auth)

20166 NO-GO THEOREM. Grodsky, I. T. (International Centre for Theoretical Physics, Trieste, Italy); Streater, R. F. Phys. Rev. Lett., 20: 695-8(Mar. 25, 1968).

It is shown that in the covariant approach there exist no systems of single-particle functions satisfying a completeness property which generate any acceptable single-particle representations of current algebras and superconvergence relations. The nonexistence of any acceptable local infinite-component field theory or wave equation is also demonstrated. (auth)

20167 CURRENT ALGEBRA: A SIMPLE MODEL WITH NONTRIVIAL MASS SPECTRUM. Leutwyler, H. (Univ., Bern). Phys. Rev. Lett., 20: 561-3(Mar. 11, 1968).

A relativistically invariant solution of the local isovector current algebra at infinite momentum is given. This solution is based on the assumption that in the infinite momentum limit the algebra is saturated by one-particle states. Restriction is made to the case of a set of particles of one and the same isospin but the spin of these particles is allowed to be arbitrary. (J.F.P.)

20168 HAMILTONIANS IN RELATIVISTIC CLASSICAL PARTICLE MECHANICS. Jordan, Thomas F. (Univ. of Pittsburgh). Phys. Rev., 166: 1308-16(Feb. 25, 1968).

Generators and Lie-bracket relations for the Poincaré group are used to develop a relativistic Hamiltonian formalism, with noncanonical Lorentz transformations, in terms of particle positions and canonical momenta. The usual transformations of particle positions are assumed, and are used to establish the correspondence between the Lie-bracket relations and invariance of the Newtonian equations of motion. The impossibility of interaction for two particles is proved assuming one property of canonical Lorentz transformations: the conventional Lorentz transformations of total energy, momentum, and angular momentum. (auth)

20169 MAXIMUM NUMBER OF COLLISIONS FOR THREE POINT PARTICLES. Doolen, Gary (Purdue Univ., Lafayette, Ind.). Phys. Rev., 166: 1651-3(Feb. 25, 1968).

A simple method of obtaining n_{max}, the maximum number of binary collisions for three point particles with masses m_1, m_2, and m_3 interacting through zero-range forces, is presented. The result is that n_{max} is the smallest integer greater than or equal to x, where $\cos(\pi/x) = [m_1 m_2/(m_1 + m_3)(m_2 + m_3)]^{\frac{1}{2}}$. (Here m_3 is the smallest mass, and $x \geq 3$.) Also, the magnitudes of the momenta after any number of classically allowed collisions are simply expressed in terms of the initial momenta. (auth)

20170 PROCEEDINGS OF THE LIPERI SUMMER SCHOOL IN THEORETICAL PHYSICS, 1967. Helsinki, University of Helsinki, 1967. 284p.

Seven lectures are included. A separate abstract was prepared for each lecture. (J.F.P.)

For abstracts of individual lectures see: 20171, 20229, 20250, 20317, 20351, 20352, and 20703.

20171 CURRENT ALGEBRA APPROACH TO ELEMENTARY PARTICLE PHYSICS. Callan, Curtis G. Jr. (Harvard Univ., Cambridge, Mass.). pp 131-57 of Proceedings of the Liperi Summer School in Theoretical Physics, 1967. Helsinki, University of Helsinki, 1967.

A concise introduction to the basic ideas of current algebra for elementary particle physics is given, and some applications are explained. Among these applications are $\nu + p$ interactions $\pi^- \rightarrow e^- + \nu$, decay, and meson (K) semileptonic decays. (J.F.P.)

20172 CURRENT ALGEBRAS AND THEIR APPLICATIONS. Renner, B. International Series of Monographs in Natural Philosophy. Volume 12. New York, Pergamon Press, Inc., 1968. 190p.

A comprehensive review is given of current algebra theory and its applications, covering literature up to Feb. 1967. Topics discussed include preliminary concepts and the basic ideas of current algebras, approximate SU(3) symmetry, dispersion theory of current algebra, current algebra sum rules with PCAC, low-energy theorems, extensions of the SU(3) × SU(3) current algebra, Schwinger terms, and possible connections of current algebras and dynamics. Some details on LSZ reduction formulas are given in the appendix. A bibliography on current algebras and selected general references are included. (LB.S.)

Electromagnetic

Refer also to abstracts 20229, 20245, and 20345.

20173 (JINR-P2-3704) MODEL VEKTORNOI DOMINANTNOSTI I PRAVILA SUMM DLYA γ p-VZAIMODEISTVIYA PRI VYSOKIKH ENERGIYAKH. (Vector Dominance Model and the Sum Rules for the High Energy Interaction). Gerasimov, S. B.; Serdyutskii, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 11p. (In Russian). Dep.

In the framework of the vector dominance model for the hadron electromagnetic interaction the sum rule is obtained connecting the γ p-interaction cross section with the constant of the photon-vector transition and with the parameters of the high energy meson-nucleon scattering. The value of the constant obtained from the sum rule is compared with the data of various experiments. (auth)

20174 (NP-17316) THE PRODUCTION OF COSMIC GAMMA RAYS IN INTERSTELLAR AND INTERGALACTIC COSMIC-RAY COLLISIONS. IV. GAMMA-RAY PRODUCTION FROM COSMIC PROTON-ANTIPROTON INTERACTIONS. Stecker, F. W. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Dec. 20, 1967. 28p. (SAO-261). Dep. CFSTI.

Various cosmological situations are discussed in which the annihilation of antimatter will produce cosmic gamma rays. An upper limit is placed on the amount of cosmic matter-antimatter interaction consistent with recent cosmic gamma-ray observations. It is shown that the production of mesons other than pions have little effect on the annihilation gamma-ray spectrum. It is also shown that gamma rays arising from annihilations at rest have energies between 5 and 865 MeV. The gamma-ray spectrum from annihilations at rest is calculated and compared with the calculations of Frye and Smith. A discussion is then presented of the various characteristics of proton-antiproton interactions in flight. Production of various mesons, hyperons, and isobars is discussed and cross sections are given. General implications of the data on the resultant gamma spectra are stated. (auth)

20175 (NP-17317) THE PRODUCTION OF COSMIC GAMMA RAYS IN INTERSTELLAR AND INTERGALACTIC COSMIC-RAY COLLISIONS. V. GAMMA-RAY PRODUCTION FROM COSMIC ELECTRON-POSITRON ANNIHILATION. Stecker, F. W. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Dec. 21, 1967. 23p. (SAO-262). Dep. CFSTI.

The annihilations of free electrons and positrons and positronium are discussed and cross sections are given. Positronium formation under astrophysical conditions is then discussed. A general formula is then derived that gives the gamma spectrum from the annihilation of cosmic positrons in terms of the positron source spectrum, energy loss rate, and annihilation cross section given as functions of energy. The gamma spectrum from the annihilation of thermal positrons is calculated, and the gamma intensity from secondary positrons is determined. The secondary positrons are considered to arise from the decay of positive mesons that are produced in galactic cosmic p-p and p-α interactions. (auth)

20176 SUPERCONVERGENCE AND CURRENT ALGEBRA FOR A SPIN-1/2 TARGET. Boiti, M.; Pempinelli, F. (Univ., Turin). Nuovo Cim. (10), 54A: 108-26(Mar. 1, 1968).

The electro- and photoproduction amplitudes on and off the pion mass shell are considered. The Khuri representation is profitably used to derive some superconvergence relations in the strong interaction case, in two different ways, and some current-algebra identities in the weak case. The Regge asymptotic behavior of the invariant amplitudes is also examined. An old familiar result is obtained by new methods. (auth)

20177 ANNIHILATION INTO TWO PHOTONS OF LEPTON PAIRS INCLUDING ANOMALOUS MAGNETIC MOMENT AND POLARIZATION EFFECTS. Shieh, Shuang-yuan (Lehigh Univ., Bethlehem, Pa.). Nuovo Cim. (10), 54A: 193-6(Mar. 1, 1968).

Results of a calculation of matrix elements for annihilation into two photons of lepton pairs with anomalous magnetic moment and polarization effects taken into account is reported. A form factor which can be considered as a product of a form factor for the vertex and a form factor for the propagator is also included. The mass terms which are usually omitted are included in the calculation so that the results can be applied to both low- and high-energy experiments. (J.F.P.)

20178 PHOTONS IN S-MATRIX THEORY. Storrow, J. K. (Cambridge Univ., Eng.). Nuovo Cim. (10), 54A: 15-41(Mar. 1, 1968).

A method of avoiding the usual difficulties which arise in defining the S-matrix for processes involving photons is described. This provides a way of formulating an S-matrix theory of electromagnetic interactions. The coherent soft-photon states and amplitudes taken between these states, called "dressed" amplitudes are used. This enables one to avoid infrared divergence difficulties and work with finite S-matrix elements. Using a perturbative method of calculation, but summing to all orders in the fine-structure constant, the cluster decomposition properties of the S-matrix and the form of the one-particle singularity are examined. It is shown that at this singularity the dressed amplitude factorizes into a product of dressed sub-amplitudes, just as the S-matrix of strong interactions factors into a product of sub-amplitudes at a pole. However, the form of the singularity is a power law stronger than a pole. Attention is confined mainly to systems with only one charged particle but the question of the divergent Coulomb phase is examined and it is shown that the dressed amplitudes do not suffer from it. (auth)

20179 NOTE ON THE S-MATRIX THEORY OF ELECTROMAGNETIC INTERACTIONS. Vrejoiu, C.; Burlacu, L.; Nicolescu, B. (Univ., Bucharest). Nuovo Cim. (10), 54A: 181-3 (Mar. 1, 1968).

The possibility of applying the S-matrix theory to electrodynamics and regaining the results of quantum electrodynamics is considered for the third-order vertex part of a single external electron line. The identity between the S-matrix theory and conventional quantum electrodynamics results is obtained through the suitable choice of the subtraction constants. It is seen that there is some similarity between the choice of the subtraction constants and the definition of the ultraviolet divergence removal procedure in quantum electrodynamics. (J.F.P.)

20180 ELECTROMAGNETIC VERTEX IN SL(2,C). Bebie, Hans (Univ., Bern). Helv. Phys. Acta, 41: 239-42(Apr. 1, 1968).

A formula for the ratio of the electric to the magnetic form factors of a spin-$\frac{1}{2}$-particle in a model is derived assuming SL(2,C) symmetry. (auth)

20181 TIME-DEPENDENT GREEN'S FUNCTION FOR ELECTROMAGNETIC WAVES IN MOVING CONDUCTING MEDIA. Besieris, Ioannis M.; Compton, Ralph T. Jr. (Case Inst. of Tech., Cleveland). J. Math. Phys. (N. Y.), 8: 2445-51(Dec. 1967).

The problem of radiation from sources of arbitrary time dependence in a moving conducting medium is treated. The medium is assumed to be homogeneous and isotropic, with permittivity ϵ, permeability μ, and conductivity σ, and to move with constant velocity v with respect to a given inertial reference frame. v may have any value up to the speed of light. It is shown how the Maxwell-Minkowski equations for the electromagnetic fields in the moving medium can be integrated by means of a pair of vector and scalar potential functions analogous to those commonly used with stationary media. The wave equation associated with these potential functions is derived, and an associated scalar Green's function is defined. The solution for the Green's function is obtained in closed form, by means of a technique making use of the relation between the fundamental solution of a radiation problem and that of a corresponding Cauchy initial-value problem. The resulting Green's function is

found to consist of an oblate spheroidal shell, similar to that which occurs in a lossless medium, plus a residue which persists after the shell. In addition, the Green's function is exponentially damped in both space and time, an effect not present in a lossless medium. (auth)

20182 SINGLE PION PHOTOPRODUCTION NEAR THRESHOLD. Weaver, D. L. (Tufts Univ., Medford, Mass.). Phys. Lett., 26B: 451-3(Mar. 4, 1968).

The latest theoretical predictions for single pion photoproduction are compared with the Kroll-Ruderman limit and a recent extension. The role of the omega meson in π^0 photoproduction is elucidated, and threshold predictions for π^0 photoproduction from neutrons are presented. (auth)

20183 PARITY DOUBLET CONSPIRACY OF THE PION FROM FINITE ENERGY SUM RULES IN π^+ PHOTOPRODUCTION. Bietti, A. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Di Vecchia, P.; Drago, F.; Paciello, M. L. Phys. Lett., 26B: 457-60(Mar. 4, 1968).

The essential features of the conspiracy of the pion Regge pole with a positive parity pole in π^+ photoproduction are tested, using finite energy sum rules. In particular it is found that the pion residue function varies rapidly with the four momentum transfer t vanishing at $t = -0.03$ GeV^2 and the conspirator trajectory chooses nonsense at $\alpha = 0$. (auth)

20184 PHOTOPRODUCTION OF THE NEUTRAL VECTOR MESONS ON NUCLEONS. Akhiezer, A. I.; Rekalo, M. P. (Inst. of Theoretical Physics, Kiev). Yadern. Fiz., 7: 120-7(1968). (In Russian).

Consequences of the quark model for the interactions of the elementary particles are considered in view of the applications to the photoproduction of the neutral vector mesons on nucleons. Exponential dependence of the differential cross sections on the momentum transfer squared is predicted and the exponents are identical for the $\gamma + N \rightarrow N + V^0$ reaction and for some processes of the elastic hadron scattering. The differential cross sections of the $\gamma + N \rightarrow N + V^0$ processes at zero angle increase as the square of the γ-quantum energy; the total cross section tends to a constant. An essential suppression of the φ production is predicted, that is in good agreement with the experimental data. (auth)

20185 MESON PHOTOPRODUCTION AND DIVERGENCE CONDITIONS. Montvai, I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 128-32(1968). (In Russian).

Some consequences of the divergence conditions for the meson photoproduction near the threshold are considered. The comparison with the data in the case of the π^+-meson photoproduction shows that good agreement can be obtained only with the value $f_\pi = 0.138$ M_N of the PCAC constant measured in the $\pi \rightarrow \mu\nu$ decay. In this case, from the reaction $\gamma p \rightarrow \pi^+ n$ one obtains $g_A/g_V = 1.20 \pm 0.02$ for the renormalization of the axial-vector coupling constant. Predictions of the theory are in good agreement with the known experimental data in other reactions except for $\gamma p \rightarrow K^+\Lambda$; in the latter case, the experimental value sharply differs from the predicted one. (auth)

20186 POLARIZATION IN THE πe SCATTERING AND THE PION ELECTROMAGNETIC FORM FACTOR. Bilen'kii, S. M.; Semikoz, V. B. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 107-10(1968). (In Russian).

Electron polarization in the πe scattering is calculated for the energy region up to the $\pi + e \rightarrow 2\pi + e$ reaction threshold. In this energy region the polarization is determined by the pion electromagnetic form factor. (auth)

20187 QUANTUM ELECTRODYNAMICS WITHOUT BARE CONSTANTS AND DIVERGENCES. Gol'fand, Yu. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 7: 183-8(1968). (In Russian).

A method for calculation of the quantum electrodynamics amplitudes without bare values of the charge and mass is considered using the Lagrangian formalism, and during the calculation there appears no divergences. The exclusion of divergences is achieved using some boundary conditions for the matrix elements of the current operator. The result is that for the amplitudes one obtains "renormalized" expressions containing only physical quantities of the constants. The method is illustrated by simple calculation of approximate expressions of the photon Green functions. (auth)

20188 LOW-ENERGY NUCLEON COMPTON SCATTERING. Koberle, R. (Univ. of Chicago). Phys. Rev., 166: 1558-67 (Feb. 25, 1968).

In the case of nucleon Compton scattering, theory and experiment disagree at the photoproduction threshold and at the peak of the first pion-nucleon resonance (1236 MeV) at 90° c.m. scattering angle. Dispersion relations are used to calculate the scattering amplitudes of this process in the low-energy region in terms of the nucleon Born pole, photoproduction, π^0, and 2π exchange. Several currently accepted models for $I = J = 0\pi\pi$ scattering are considered. Using a nonresonating or a resonating $\pi\pi$ phase shift with resonance width $\gtrsim$100 MeV and position $\geq$600 MeV, discrepancy is accounted for between theory and experiment around the photoproduction threshold. At the 90° c.m. resonance peak, the situation remains essentially unchanged. (auth)

20189 DOES THE ELECTROMAGNETIC CURRENT HAVE AN I = 2 COMPONENT? Divakaran, P. P.; Gupta, V.; Rajasekaran, G. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 166: 1792-4(Feb. 25, 1968).

The possibility that the electromagnetic current may have a part transforming like I = 2, with C = −1, in addition to the usual I = 0 and I = 1 parts is considered. It is argued that there is no evidence at present to exclude such a hypothesis. Some consequences and tests of the hypothesis are discussed. (auth)

20190 $K_{\pi 3}$ BRANCHING RATIOS: MASS-DIFFERENCE CORRECTIONS AND AMBIGUITIES IN INTERPRETATION. Devlin, Thomas J. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev. Lett., 20: 683-6(Mar. 25, 1968).

The method of testing isospin selection rules by comparison of partial rates for 3π decay of K mesons is investigated, considering the following processes: $K^\pm \rightarrow \pi^\pm\pi^+\pi^-$, $K^\pm \rightarrow \pi^0\pi^0\pi^\pm$, $K_2^0 \rightarrow \pi^+\pi^-\pi^0$, and $K_2^0 \rightarrow \pi^0\pi^0\pi^0$. It is pointed out that, in the cases of $\pi^0\pi^0\pi^\pm$ and $\pi^+\pi^-\pi^0$ final states, the assumption that the integral over phase space of the first order term is zero is incorrect. Various quantities involved in mass difference corrections to the branching ratios are calculated. (L.B.S.)

20191 VECTOR AND SPINOR CURRENT ALGEBRA AND THE N/D METHOD. Drummond, I. T. (Univ. of Cambridge, Eng.). Nuovo Cim. (10), 53A: 577-91(Feb. 1, 1968).

An N/D model of weak amplitudes analogous to the ladder approximation of Bronzan, Gerstein, Lee and Low is discussed. It is applied to the case of vector-vector current commutators and spinor-spinor anticommutators. The model does not of course yield the detailed assumptions of current algebra but is consistent with them. It shows how these assumptions are compatible with the analyticity properties usually assumed for invariant amplitudes. By means of the model it is possible to indicate the problems involved if a bootstrap calculation is to yield the results of current algebra. (auth)

20192 LOW-ENERGY THEOREMS FOR PHOTON PROCESSES. Bardakci, Korkut (Univ. of California, Berkeley); Pagels, Heinz. Phys. Rev., 166: 1783-91(Feb. 25, 1968). (UCRL-17857).

Various methods of obtaining low-energy theorems for photon processes are reviewed and discussed: (1) Low's method, (2) the tensor method, and (3) the S-matrix approach. The purely kinematical nature of these theorems is emphasized, for they are found to follow primarily from the identification of the correct amplitudes free of kinematical singularities and zeros. Gauge invariance serves to inform us of the presence of additional kinematical zeros in certain physical amplitudes, so that the unknown continuum contribution is suppressed relative to the known singular Born terms arising from single-particle exchange at the physical threshold. Besides the well-known low-energy theorems specifying Compton amplitudes to first order in the photon frequency, it can be shown that some pieces of the amplitude satisfy higher-order theorems; in fact, all $2J + 1$ multipoles of a spin-J target have an associated low-energy theorem. A low-energy theorem for the quadrupole moment of a J = 1 target is explicitly established to supplement the known theorems for the total charge and magnetic moment. An additional theorem for photopion production is obtained along with the well-known Kroll-Ruderman theorem, and serves to specify the E_2^- multipole at threshold. (auth)

20193 π^+ PHOTOPRODUCTION ABOVE $E_\gamma = 1$ GeV NEAR THE FORWARD DIRECTION. Engels, J. (Technische Hochschule, Karlsruhe, Ger.); Schwiderski, G.; Schmidt, W. Phys. Rev., 166: 1343-5(Feb. 25, 1968).

π^+ photoproduction is considered near the forward direction and at medium high energies $1 < E_\gamma < 3$ GeV. It is shown that with a simple isobar ansatz in fixed-t dispersion relations the main features of the angular distributions can be predicted in the region which is covered by recent measurements at DESY. The results indicate the importance of certain contact contributions of the resonances which are not taken into account by the peripheral models presented up to now. (auth)

20194 ABSORPTION IN HIGH-ENERGY PHOTOPRODUCTION. Ross, D. K. (Stanford Univ., Calif.). Phys. Rev., 166: 1521-4(Feb. 25, 1968).

Absorption in high-energy photoproduction was derived using a Regge amplitude. It is found that this depends strongly on the square of the four-momentum transfer t, smaller values of |t| giving much less absorption. This behavior differs markedly from that of the Drell peripheral model with a constant absorption factor. The absorption is calculated for s and t values corresponding to energies encountered in a recent SLAC experiment, and is seen to reduce the cross section by factors of $\frac{1}{120}$ to $\frac{1}{25}$, depending on t. Factors of this order are needed to bring experiment and theory into agreement. The high-energy asymptotic behavior of the amplitude with absorption is found to differ from the usual Regge behavior. The usual absorption using a Born amplitude is also elaborated and generalized and is compared with recent DESY data. The well-known high-energy Regge behavior of the cross section without absorption, $d\sigma/dt = C(t)s^{2\alpha(t)-2}$, is derived for all spins in an Appendix. (auth)

20195 WIDTH $\Gamma_{X^0\to 2\gamma}$ AS A TEST OF THE MASS FORMULA FOR BOSON NONETS. Guerra, F. (Univ., Naples. Istituto Nazionale di Fisica Nucleare, Naples); Vanoli, F.; De Franceschi, G.; Silvestrini, V. Phys. Rev., 166: 1587-8(Feb. 25, 1968).

It is generally believed that the physical η and X^0 particles are not pure SU_3 states, but result from octet-singlet mixing. Depending on the assumption of a linear or quadratic mass formula, different values can be obtained for the mixing angle. The latter can be used in turn to estimate the width of $X^0 \to 2\gamma$ using the experimental values of $\Gamma_{\eta\to\gamma\gamma}$ and $\Gamma_{\pi^0\to\gamma\gamma}$. Note that the quadratic mass formula predicts values considerably larger than the linear one. An upper bound of 20–30 keV for the $X^0 \to 2\gamma$ width, which is not outside the experimental possibilities—e.g., with the Primakoff-effect technique—would be evidence against the use of a quadratic mass formula within the standard SU_3 scheme. (auth)

20196 C-CONSERVING DECAY MODES $\eta \to \pi^0 e^+ e^-$ AND $\eta \to \pi^0 \mu^+ \mu^-$. Smith, J. (Univ. of Adelaide). Phys. Rev., 166: 1629-32(Feb. 25, 1968).

Using an S-wave $\eta\pi^0 2\gamma$ coupling $\eta\pi^0 F_{\mu\nu}F^{\mu\nu}$, a calculation is made of the C-conserving two-photon-exchange diagrams for the decays $\eta \to \pi^0 e^+ e^-$ and $\eta \to \pi^0 \mu^+ \mu^-$. The branching ratios $R_1 = \Gamma(\eta \to \pi^0 e^+ e^-)/\Gamma(\eta \to \pi^0 2\gamma)$ and $R_2 = \Gamma(\eta \to \pi^0 \mu^+ \mu^-)/\Gamma(\eta \to \pi^0 2\gamma)$ do not depend upon any unknown coupling constant and have lower bounds determined by unitarity. A cutoff on the real part of the matrix elements at $\Lambda = 2M_\eta$ yields the results $R_1 = 3.6 \times 10^{-3}$ and $R_2 = 0.6 \times 10^{-4}$. (auth)

20197 PHOTOPRODUCTION OF CHARGED PIONS IN THE FORWARD DIRECTION AND REGGE POLES. Cooper, Fred (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett., 20: 643-6(Mar. 18, 1968).

A test using linearly polarized photons, of the hypothesis that the forward peak in charged-pion photoproduction is due to a conspiracy between the pion and an opposite-parity conspirator is proposed. The energy dependence of the differential cross section for photons linearly polarized in the plane of scattering can distinguish between a nucleon pole leading to the forward peak or a pion conspirator. (auth)

Weak

Refer also to abstract 20177.

20198 (CONF-670211–, pp 6-33) EXPERIMENTAL ASPECTS OF NEUTRAL K DECAY INTO TWO PIONS. Abashian, A. (Argonne National Lab., Ill.).

The two parameters for $K^0 \to 2\pi^0$ decay η_+ and η_{00} are considered, and the current experimental situation is discussed. Also, some experiments which led up to the experiments which determine the phase of η_+ and the magnitude of η_{00} are briefly reviewed. It is concluded that the experiments on the phase of η_{+-} indicate that it is probably not too far from the value $\tan^{-1}(2\delta/\tau S) \approx 45°$. Three experiments appear to be consistent with one another. The greatest uncertainty lies in the determination of the regenerative phase rather than in the experiments themselves. Two experiments on the magnitude of η_{00} indicate that it is not equal to the magnitude of η_{+-} but is appreciably larger. This indicates that the violation cannot be completely in the mass matrix itself but must arise to some extent from Im $A2/A^0$ not being equal to zero. A possible solution, in fact, is $\epsilon = 0$. (J.F.P.)

20199 (CONF-670211–, pp 34-45) IMPLICATIONS OF THE RECENT MEASUREMENTS OF $K_L \to \pi^0\pi^0/K_L \to \pi^+\pi^-$ BRANCHING RATIO. Truong, T. (Argonne National Lab., Ill.).

The discussion of the implications of recent measurements of the $K_L \to \pi^0 + \pi^0/K_L \to \pi^+ + \pi^-$ branching ratio includes a summary of experimental results and a phenomenological analysis. The CP violation is assumed to be of weak interaction origin. The measured value $|\eta_{00}|$ may also be consistent with the possibility of C violation in electromagnetic interactions. It is noted that the previous proposal that ϵ may be purely imaginary can only be consistent with the experimental upper limit on CP violation in the leptonic and 3π modes if ϵ is small. In particular, if there was no CP violation in 3π and leptonic modes, this theory would require $\eta_{00} = -2\eta_{+-}$. (J.F.P.)

20200 (CONF-670211–, pp 46-56) FUTURE EXPERIMENTS [ON CP VIOLATION]. Wattenberg, A. (Argonne National Lab., Ill.).

Other weak decays as well as that of the meson (K^0) are considered. Some presently planned experiments and those to be possibly carried out within about the next year are discussed. Their implications and the information lacking even after these experiments are completed are given. (J.F.P.)

20201 CHARGE FORM FACTOR AND VACUUM POLARIZATION CORRECTIONS TO THE μ^--CAPTURE RATE IN ^{3}He. Lin, D. L. (State Univ. of New York, Buffalo); Lassila, K. E. Nuovo Cim. (10), 54A: 164-73(Mar. 1, 1968).

The form factor analysis by Schiff of electron-tri-nucleon scattering data and the dipole nucleon form factors are used to obtain the charge density function for ^{3}He. This is employed, along with the vacuum polarization contribution, to calculate a reliable finite size correction to μ^--meson capture rates in ^{3}He. A reduction of 3.43% from the commonly used value for the muon density inside the nucleus calculated from the nonrelativistic wave function for a point charge is found. Incorporation of the corrections into previous theoretical μ^--capture analyses leads to strengthening of Oakes' conclusion on the preference of the Irving over the Irving–Gunn form of the three-nucleon wave function and brings one of the induced tensor coupling constant values found by Bietti into agreement with the recent work of Fearing which yielded $g_T^{(\mu)} \gtrsim 35 g_v^{(\mu)}$. (auth)

20202 DIRECT PRODUCTION OF MUONS IN COSMIC RAYS? Nash, W. F. (Univ. of Nottingham, Eng.); Wolfendale, A. W. Phys. Rev. Lett., 20: 698-700(Mar. 25, 1968).

Experimental data are examined relevant to the previous conclusion that the majority of cosmic mesons (μ) of energy above 1000 GeV are produced either directly or as decay products of very short-lived secondaries ($\tau \ll 10^{-6}$ sec) and to results indicating that direct production is dominant as low as 500 GeV. In particular the direct measurement of near vertical and inclined meson (μ) spectra at ground level is considered. It is found that the inclined meson (μ) spectrum measurements do not support the suggestion that an appreciable fraction of the mesons (μ) of energy below 1000 GeV are produced directly. (J.F.P.)

20203 NEUTRAL CURRENTS IN WEAK INTERACTION THEORY. Ioffe, B. L.; Shabalin, E. P. JETP Lett. (USSR) (Engl. Transl.), 6: 390-3(Dec. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 978-81(Dec. 1, 1967).

It is shown that it is possible to eliminate the additional hypotheses concerning the asymptotic behavior of certain amplitudes at large momenta (for example, an amplitude proportional to the divergence of the axial current) assuming that the asymptotic behavior of the amplitude when $k_0 \to \infty$ and k = constant is described by the Bjorken formula. This analysis is applied to the $K_2^0 \to \mu^+ + \mu^-$ decay. (J.F.P.)

20204 $K_L^0 \to \pi^0 e^+ e^-$ AND CP NONCONSERVATION. Tsai, S. Y. (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 38: 1409-10(1967).

It is pointed out that if the hypothesis that the electromagnetic interaction of hadrons badly violates C and T invariance is valid, the CP violating process $K_L^0 \to \pi^0 + e^+ + e^-$ may be enhanced by some dynamical reason and its branching ratio may be as large as about 10^{-6}. It is found that the width of the studied decay is 22 sec^{-1} and the branching ratio is about 1.2 $(10)^{-6}$. It is concluded experimental data on this decay would give useful information concerning possible C invariance violation in electromagnetic interactings of hadrons. Finally, it is noted that the rate of the CP conserving decay $K_S^0 \to \pi^0 + e^+ + e^-$ about 2 sec^{-1} and the branching ratio is approximately 1.7 $(10)^{-10}$. (J.F.P.)

20205 LONG-RANGE FORCES FROM NEUTRINO-PAIR EXCHANGE. Feinberg, G. (Columbia Univ., New York); Sucher, J. Phys. Rev., 166: 1638-44(Feb. 25, 1968). (NYO-1932(2)-128).

The long-range forces arising from neutrino-pair exchange between elementary systems are studied with the use of dispersion-theoretic techniques previously applied to the study of multiphoton exchange. It is shown that the potential decreases as r^{-5} for large separation r, independently of the particles or systems under consideration. The weak lepton-lepton force does not seem to be observable at present in laboratory experiments. The long-range forces on neutrinos are also studied. For the case of two neutral

molecules, a numerical comparison is made of the three types of long-range forces: gravitational, electromagnetic, and weak. (auth)

20206 UNITARITY AND RADIATIVE DECAY PROCESSES. Gaillard, M. K. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim. (10), 53A: 777-97(Feb. 1, 1968).

By means of the unitarity condition, a study is made of the contribution of radiative $\pi\pi$ scattering to the matrix elements for radiative-decay processes such as $K \rightarrow 2\pi\gamma$. In particular, the final-state interaction phases associated with direct emission (as distinguished from bremsstrahlung) amplitudes in radiative decays depend on the importance of the corresponding direct emission amplitudes in radiative scattering. The cases of T-invariance and T-violation are considered separately, assuming CPT invariance throughout. In the limit of T-invariance it is found that the phase of direct emission amplitude corresponding to a final-state di-pion system of angular momentum l is just the appropriate $\pi\pi$ scattering phase shift δ_l in the following cases: 1) The corresponding amplitude is forbidden in radiative scattering (e.g., magnetic emission for all l in spin-zero boson decays). 2) The nonradiative decay is forbidden (e.g., η-decay and K_S^0 decay). For K^+ decay the nonradiative decay is suppressed relative to direct emission by the $|\Delta I| = 1/2$ rule; hence the approximation of a phase δ_l for electric as well as magnetic amplitudes may be reasonable. For the case of T-violation, the partial-wave amplitudes $D_l(\bar{D}_l)$ for direct emission in radiative K ($\bar{K}$) decay into a final di-pion state of angular momentum l are related by $\bar{D}_l = \pm D_l^* \exp[2i\delta_l]$, if condition 1) or 2) above holds. The case in which these conditions do not hold is also considered. It is found that CP-violating effects such as difference in rates and spectra for radiative K^+ and K^- decays, or an interference between K_L and K_S amplitudes remain nonvanishing in the latter case. (auth)

20207 U-SPIN POLE MODEL OF NONLEPTONIC HYPERON DECAYS. Good, M. L.; Nieto, Michael Martin (State Univ. of New York, Stony Brook). Phys. Rev. Lett., 20: 624-7(Mar. 18, 1968).

A model is proposed for nonleptonic hyperon decays which gives good experimental agreement for both S and P waves, and hence the decay parameters α, and requires the $\Delta I = 1/2$ rule. The model demands the suppression of certain pole terms. The remaining terms behave like transitions caused by U-spin raising or lowering operators acting on Y = 0 states. (auth)

20208 K_1^0-K_2^0 MASS DIFFERENCE AND THE INTERMEDIATE VECTOR BOSON. Cosslett, S. R. (Cambridge Univ., Eng.). Phys. Rev. Lett., 20: 634-6(Mar. 18, 1968).

The $K_1^0 - K_2^0$ mass difference is calculated to lowest order in the intermediate-boson model, using Weinberg's first sum rule. A finite result is obtained without requiring equal coupling of strange and nonstrange mesons to the corresponding currents. (auth)

20209 POSSIBLE EXPLANATION OF ANOMALIES IN NEUTRAL K PHENOMENA. Spitzer, R. (Univ. of California, Berkeley). Nature (London), 217: 943-5(Mar. 9, 1968). (UCRL-70871).

It is stated that the experimental results usually interpreted as evidence for CP violation in neutral K decay have been found to be inconsistent with the values of all the relevant observables obtained from other measurements. In particular, either the $K_L - K_S$ mass difference or the difference $\delta_2 - \delta_0$ between two pion-pion scattering phases, as determined by phenomenological analysis of the former data, has an opposite sign from that obtained by independent measurements of these two quantities. This result cannot be accounted for by any existing CPT-conserving theory of CP violation. Such a possibility can, however, be accommodated within the theory in which the effects in question are due not to CP violation but to the interaction of neutral K mesons with external electromagnetic fields. If this is so, the relevant amplitude for field induced $K^0 - \bar{K}^0$ interconversion or K decay is, to lowest order, almost certainly linear in external field. The origin of such an amplitude is considered. If interaction with electromagnetic fields is responsible for the anomalous effects, such as 2 π decay and charge asymmetry at large distances from the target, then these can all be completely eliminated by properly shielding the external fields. (UK)

Strong (General)

20210 (CERN-67-24(Vol.2)) HIGH-ENERGY PHENOMENOLOGY AND REGGE POLES. Svensson, B. E. Y. (Lund Univ. (Sweden). Dept. of Theoretical Physics. European Organization for Nuclear Research, Geneva (Switzerland)). Dec. 20, 1967. 204p. Dep.

From Proceedings of the 1967 CERN School of Physics, Raettvik, May 21–June 3, 1967.

The basic theoretical arguments underlying the Regge pole model as well as its applications to particle (stable particle or resonance) classification and to reactions at incident laboratory momentum greater than 5 GeV/c are presented. A theoretical background is given and a wave description is used. Efforts are made to remain close to experimental findings. A survey of results on total cross sections, most aspects of elastic scattering, and some representative inelastic two-body processes is given. The presentation of the Regge pole model is not rigorous. The basis for classification of hadrons on Regge trajectories is discussed and illustrated by the nonstrange mesons and fermions. Application to high-energy reactions is extensively illustrated for pion–nucleon elastic and especially charge-exchange scattering. Nucleon–nucleon and kaon–nucleon reactions are treated briefly. (J.F.P.)

20211 (INP-555/PH, pp 1-4) A DYNAMICAL THEORY OF QUARKS. Rayski, J. (Jagellonian Univ., Krakow (Poland). Inst. of Physics).

A dynamical quark model is described. From this model the numerical mass of quarks can be determined, and the masses of the meson and baryon multiplets can be found. In this model pairs of a quark and antiquark and triplets of quarks or antiquarks form strongly bound systems, pairs of two quarks or antiquarks and triplets of two quarks and an antiquark (or vice versa) do not form strongly bound systems. (J.F.P.)

20212 (INP-555/PH, pp 115-20) SOME ASPECTS OF THE QUARK MODEL. Werle, J. (Warsaw Univ. (Poland). Inst. of Theoretical Physics).

The discussion of aspects of the quark model includes the assumptions used in the various quark models, and the main difficulties encountered which are a lack of experimental evidence for stable particles with charges $\pm 1/3$ e or $\pm 2/3$ e, problems with statistics, and incorrect prediction in the theory of reactions. (J.F.P.)

20213 (JINR-P2-3661) SPEKTRAL'NOE PREDSTAVLENIE DEZERA-GIL'BERTA-SUDARSHANA I MATRICHNYE ELEMENTY KOMMUTATOROV TOKOV PRI RAVNYKH VREMENAKH V TEORII VOZMUSHCHENII. (Deser–Hilbert–Sudershan Spectral Representation and Matrix Elements of Equal Time Current-Current Commutators in the Perturbation Theory). Usyukina, N. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 17p. (In Russian). Dep.

Deser-Hilbert-Sudershan spectral representation for the matrix element $\langle p|[j_\mu^a(x/2)j_\nu^b(-x/2)]|0\rangle$ in the lowest order of the perturbation theory for renormalizable quark model with bare Lagrangian of interaction $L_{int}(x) = g_s : \bar{\psi}(x)\psi(x)\phi_s(x) : + ig_p : \bar{\psi}(x)\gamma^5\psi(x)\phi_p(x) : + g_v : \bar{\psi}(x)\lambda_\beta^\alpha\psi(x)a_\mu^\alpha(x) :$ is considered. The value of the matrix element $\langle p|[j_\mu^a(x/2)j_\nu^b(x/2)]|0\rangle$ is considered for equal times on the basis of this representation. (auth)

20214 DERIVATION OF THE KSFR RELATION. Acharya, R.; Aly, H. H.; Mavromatis, H. A.; Schilcher, K. (American Univ., Beirut). Nuovo Cim. (10), 54A: 179-80(Mar. 1, 1968).

A new derivation of the Kawarabayashi–Suzuki–Fayyazuddin–Riazuddin (KSFR) relation is sought. The starting point is the Gilman–Harari sum rules for forward $\pi - \rho$ scattering. It is found that the KSFR relation is rigorously valid provided $m_{A_1} = \sqrt{2}m_\rho$ and $m_\pi = 0$. For finite pions the generalized KSFR relation is given. (J.F.P.)

20215 QUARK MODEL OF NUCLEAR MATTER AND THE QUARK MASS. Filimonov, V. A. Yadern. Fiz., 7: 74-5(1968). (In Russian).

Nuclear matter is considered as the Fermi gas of quarks. Using the data on the masses and dimensions of nuclei, one finds the dependence between the quark mass and the range of the quark-quark forces. The quark mass is estimated as $m_q \approx 350$ MeV. (auth)

20216 SUPERCONVERGENCE RELATIONS AND THE QUARK MODEL. Neville, Donald E. (Univ. of California, Livermore). Phys. Rev., 166: 1665-76(Feb. 25, 1968).

It is shown that if $M_iM_j \rightarrow M_k$ and $B_iM_j \rightarrow B_k$ couplings (M = meson, B = baryon) are given an algebraic structure suggested by the quark model with $\mathscr{S}$ excitation, then these couplings will render superconvergent all those $M_1M_2 \rightarrow M_3M_4$ and $B_1M_2 \rightarrow B_3M_4$ scattering amplitudes having helicity flip ≥ 1 and $\alpha(0) < 0$, where $\alpha(0)$ is the intercept of the highest-lying Regge trajectory in the crossed t channel. It is supposed that the channels having $\alpha(0) > 0$ are those which are predicted to contain a Regge trajectory by an $\mathscr{S}$-excitation quark model which reduces to an SU(6) 35 + 1 of mesons at the $\mathscr{S} = 0$ level. Quark spin and angular-momentum variables $\mathscr{S}$ and $\mathscr{L}$ are introduced into the calculation and used to label the resonances, although no use is made of the potential-

theoretic concepts usually associated with the quark model. The resonance masses are assumed independent of $\mathscr{P}$, but may be $\mathscr{P}$-dependent. The S matrix, though SU(6)-symmetric in its $\mathscr{P}$ dependence, is both relativistically covariant and unitary. The amplitudes are rendered superconvergent at all angles except near the backward direction (i.e., near the point where presumably the t-channel Regge poles no longer control asymptotic behavior). The theory predicts a 70 baryon quark tower in addition to the 56, and a 1 meson tower in addition to the 35. The theory is therefore self-consistent, in that the meson resonances predicted to occur in the direct channel are the same as those assumed to exist in the crossed t channel. When "broken" to the SU(3) level, the theory predicts that every 1 will be accompanied by an 8 having the same mass and spin parity; and similarly, every 10 will be accompanied by an 8. In the BB channel, the present method does not succeed in making all $\alpha(0)<0$ channels superconvergent; however, the choice of coupling which makes the most such channels superconvergent predicts either a 490 or a 1050 multiplet (not both) coupled to S-wave 56 56 states. An appendix contains an elementary discussion of superconvergence relations in the helicity formalism, and another appendix gives the s-to-t SU(n) crossing matrix for the process $56\ \bar{5}\bar{6} \rightarrow 56\ \bar{5}\bar{6}$ (when n = 6) or $10\ \bar{1}\bar{0} \rightarrow 10\ \bar{1}\bar{0}$ (when n = 3). (auth)

20217 MESON DECAYS AND THE PION MASS DIFFERENCE. Brown, Laurie M.; Munczek, Herman (Northwestern Univ., Evanston, Ill.). Phys. Rev. Lett., 20: 680-2(Mar. 25, 1968).

A Lagrangian model of π-A_1 mixing in the presence of divergenceless vector fields is discussed, which permits the calculation of satisfactory rho- and A_1-meson decay widths. The pion mass difference (for physical pions) is finite and approximately 5 MeV when the A_1 has unit magnetic moment. (auth)

20218 ANALITICHESKIE SVOISTVA DIAGRAMM FEINMANA V KVANTOVOI TEORII POLYA. (Analytic Properties of Feynman Graphs in Quantum Field Theory). Todorov, I. T. Sofia, Izdatel'stvo Bolgarskoi Akademii Nauk, 1966. 136p.

A systematic study of analytic properties in perturbation theory is given. An integral representation for the contribution of an arbitrary Feynman graph is derived in terms of its incidence matrix. The obtained expression is an analytic function of the external momenta p in the domain where a quadratic function of p Q(a,p) is negative (for all a in the range of integration). The notion of Euclidean momenta is introduced and an important minimum property of Q(a,p) is proved which lies in the basis of the majorization method. The majorization of graphs for Euclidean external momenta is considered. The perturbation theoretic series for the two-point Green function ("the self energy"), for the vertex part, and for two-particle scattering are studied and the majorizing ("primitive") graphs are found for each of these series. All types of strong interactions are taken into account in the diagrams, though only scattering processes involving pions and nucleons as initial and final particles are considered. So, internal lines may be associated to strange particles and an arbitrary number of lines may meet in a vertex, the general case being reduced to the simplest one, in which three lines enter each vertex (only in the case of pion-pion scattering four-lines vertices are considered). The reduction of the infinite set of all strongly connected graphs of a given process to a small number of majorizing diagrams is the central and most difficult point in the proof of analytic properties in perturbation theory. The preceding results are used to obtain some common complex analyticity domain for all graphs of a given process. From here different spectral representations and dispersion relations are derived. In particular a Nakanishi-type integral representation for the vertex part is proved, which completely reflects its analytic properties. Dispersion relation for partial-wave amplitudes are derived for the pion-pion and nucleon-nucleon scattering. The motion of an anomalous threshold is also introduced and is illustrated by the example of the vertex part. An investigation of the complex singularities of an arbitrary diagram is given. Parametric equations are derived for the surface of proper singularities (the Landau surface) of a graph and their application is illustrated by several examples. (auth)

20219 CONSTRUCTION OF SOLUTIONS TO SUPERCONVERGENCE RELATIONS. Atkinson, D.; Halpern, M. B. (Univ. of California, Berkeley). Phys. Rev., 166: 1724-6 (Feb. 25, 1968). (UCRL-17880).

Superconvergence relations for $t \leqq 0$ are studied in the one-tower approximation, and a simple method for their solution is introduced. In general, it is found that, given a mass spectrum and one solution for the couplings, an infinite number of other solutions can be constructed. In simple cases, the first solution is also constructed (auth)

20220 GRIBOV-POMERANCHUK PHENOMENON IN N/D APPROACH. Joshi, G. C.; Ramachandran, R. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., 166: 1832-40(Feb. 25, 1968).

A detailed study of the left-hand function of the Froissart-Gribov representation enables the integral equation for the N function to be reduced to a form studied by Tamarkin. It can be shown explicitly that the N function develops an essential singularity and causes an infinite number of Regge poles to accumulate at $l = -1$. When moving cuts are introduced, the integral equation, when again reduced to Tamarkin form, gives conditions on the discontinuity across the cuts for eliminating the essential singularity. The technique in the present form, however, is applicable only to the right-most singularity in the complex angular momentum plane. Extensions of these techniques for π-N scattering (in the s channel) are given as an example of the inclusion of spin effects. (auth)

20221 INTERPRETATION OF RECURRING MINIMA IN ELASTIC SCATTERING AT LARGE MOMENTUM TRANSFERS. Barger, V. (Univ. of Wisconsin, Madison); Phillips, R. J. N. Phys. Rev. Lett., 20: 564-6(Mar. 11, 1968).

Maxima and minima recently reported in forward elastic scattering at moderately high energy and large momentum transfer are correlated with exceptional points $\alpha = 0, -1, -2, \ldots$ on the P' and ω Regge trajectories. An Ansatz for the Regge residue functions is given that reproduces the qualitative features of the new data. This interpretation leads to further predictions that can be experimentally checked. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 20174 and 20242.

20222 (INP-555/PH, pp 107-14) HOW TO FIND CONSPIRACY EQUATIONS. Hoegaasen, H. (European Organization for Nuclear Research, Geneva (Switzerland)).

Helicity amplitudes continued from the physical region of one process $\pi\rho \rightarrow N\bar{N}$, which is called the t channel, to the physical region of the process $\pi N \rightarrow \rho N$, called the s channel, are considered. It is shown how the constraints can be obtained from the crossing relations. (J.F.P.)

20223 PION FORM FACTOR AS A PROBE OF PION-PION P-WAVE DYNAMICS. Bergia, S. (Univ., Modena, Italy. Istituto Nazionale di Fisica Nucleare, Bologna); Mignaco, J. A. Nuovo Cim. (10), 54A: 197-202(Mar. 1, 1968).

A fit of the meson (π) form factor in the timelike region is given in terms of the Omnes-Mushkelishvili solution of the dispersive integral equation. The resulting phase shift exhibits the gross features of meson (π)-meson (π) P-wave dynamics. The mass of the resonance is well determined at about 780 MeV, widths between 110 and 130 are favored, although no clear-cut determination is allowed by existing data. (J.F.P.)

20224 FUNCTIONAL DERIVATIVES AND VECTOR MESON FIELDS. Chen, Tuan Wu (Univ. of Toronto). J. Math. Phys. (N. Y.), 8: 2342-6(Dec. 1967).

More general functional derivatives for vector mesons are introduced. As an application, a finite theory is formulated for neutral vector fields based on the "strong" Lorentz condition together with the other usual assumptions of asymptotic quantum field theory. (auth)

20225 BETHE-SALPETER EQUATION IN MOMENTUM SPACE. Saenger, Robert M. (Stanford Univ., Calif.). J. Math. Phys. (N. Y.), 8: 2366-75(Dec. 1967).

The Wick transformation in momentum space is modified to include all scattering energies by use of a coordinate surface which possesses limited detours into the complex relative energy plane. This device retains the simple form of the equation for the Bethe-Salpeter amplitude $\psi(p,p_0)$. It is shown that the transformation is valid if $\psi(p,p_0)$ has the cut structure indicated by field theory, and this structure is shown to be consistent with the Bethe-Salpeter equation provided the interaction V(x) satisfies a simple causality condition. It is further shown that the cut structure of a solution to the transformed equation can be deduced from the causal structure of the interaction alone without reference to field theory. Basic properties of the transformed equation are derived and a numerical treatment for purely elastic scattering is presented. (auth)

20226 s-WAVES OF LOW ENERGETIC $\pi\pi$-SCATTERING. Serebryakov, V. V.; Shirkov, D. V. (Inst. of Mathematics and Computer Center, Novosibirsk, USSR). Yadern. Fiz., 7: 170-7 (1968). (In Russian).

It is shown that the account of the short-wave repulsion in the low-energetic $\pi\pi$-scattering can result in the small negative s-wave in the channel I = 2 and in the anomalous behavior of the s-wave in the channel I = 0. This anomalous behavior is determined by the appearance of the low-energetic subthreshold zero in the partial wave a_0^0. It is established that the solutions obtained agree with the experimental data on $\pi\pi$-interaction in the channels I = 0,2. (auth)

20227 SUM RULES FOR THE COUPLING CONSTANTS OF THREE BOSON OCTETS. Sabo, V. I. (Uzhgorod State Univ., USSR). Yadern. Fiz., 7: 133-5(1968). (In Russian).

On the basis of the equal-time current algebra and of the hypothesis of the partially conserved axial-vector current, the relations between the constants $f(A_2\pi\eta)$, $f(A_2KK)$, $f(K^{**}K\pi)$ and $f(K^{**}K\eta)$ are obtained in the two assumptions—that K^{**} and A_2 belong to the octet $J^P = 2^+$ and that K^{**} and A_2 belong to the 27-plet $J^P = 2^+$. It is shown that these relations are best satisfied in the assumption that K^{**} and A_2 belong to the octet 2^+. The relations obtained do not coincide with those previously obtained by means of the purely group-theoretical method in the framework of a version of the SU(3) symmetry violation. (auth)

20228 PAULI APPROXIMATION FOR VECTOR BOSONS. Borgardt, A. A.; Karpenko, D. Ya.; Kompaniets, V. G. (Dnepropetrovsk State Univ., USSR). Yadern. Fiz., 7: 105-6(1968). (In Russian).

The nonrelativistic approximation with conserved spin is considered for the Kemmer equation in the Hamilton form with the external electrostatic field taken into account. It is shown that the spin-orbital interaction arises in the $1/c^4$ approximation in contrast to the case of the relativistic electron. (auth)

20229 MESON DYNAMICS. Singer, Paul (Univ. of Helsinki). pp 225-76 of Proceedings of the Liperi Summer School in Theoretical Physics, 1967. Helsinki, University of Helsinki, 1967.

The discussion of meson dynamics covers current algebra, PCAC, and meson–meson interactions including consistency relations, sum rules and pion scattering lengths. The current algebra approach to radiative decays and the connection with vector meson dominance is discussed, and the various decay modes of the meson (η) are considered with a brief mention of the meson (η) lifetime. (J.F.P.)

20230 ABSORPTION MODEL AND U(6,6) FOR THE REACTIONS $p\bar{p} \rightarrow Y\bar{Y}$. Migneron, J. H. R. (Imperial Coll. of Science and Tech., London); Watson, H. D. D. Phys. Rev., 166: 1654-64(Feb. 25, 1968).

The U(6,6) symmetry is used to write down peripheral amplitudes for the processes $p\bar{p} \rightarrow (K,K^*)Y\bar{Y}$. The requirements of unitarity are approximately enforced on the amplitudes so derived by the inclusion of absorptive corrections. Assuming a value of $G_{\pi NN}^2/4\pi$ and adopting a prescription for dealing with the mass splitting in U(6,6), satisfactory agreement is found for the angular distributions in all cases and satisfactory absolute values are obtained for $\Lambda\bar{\Lambda}$ and $\Sigma^+\bar{\Sigma}^-$, but not $\Lambda\bar{\Sigma}^0$. The energy variation of the cross section is satisfactorily reproduced for $\Lambda\bar{\Lambda}$ and $\Sigma^+\bar{\Sigma}^-$ in the intermediate momentum range from 3.0 to 5.7 GeV/c; but not for $\Lambda\bar{\Sigma}^0$. (auth)

20231 SUPERCONVERGENCE SUM RULES FOR MESON–MESON SCATTERING. Vaishya, J. S. (National Physical Lab., New Delhi. Univ. of Delhi). Phys. Rev., 166: 1822-5(Feb. 25, 1968).

Superconvergence sum rules were obtained for pseudoscalar mesons scattered by spin-2^+ mesons. Results for A_2-π and K^{**}-π scattering were compared with experiments. In general, saturation by low-lying single-particle intermediate states is found to be poor. (auth)

20232 REGGE-POLE EXCHANGE AND DIRECT-CHANNEL RESONANCES IN MODELS FOR HIGH-ENERGY SCATTERING AMPLITUDES. Durand III, Loyal (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 166: 1680-90 (Feb. 25, 1968).

The behavior of the forward and backward πN scattering amplitudes for momenta of 1–5 BeV/c has been analyzed recently using models in which Breit-Wigner amplitudes describing direct-channel resonances are added to a background amplitude given by the Regge-pole-exchange model. Although remarkably successful in practice, the model has severe theoretical limitations, especially with regard to the treatment of the tails of the resonant terms, double counting of the background contributions, and the restriction to the Breit-Wigner approximation for sets of isolated resonances. The theory of Regge-pole–plus-resonance (RPR) models is examined in detail for both single-channel potential scattering and the many-channel relativistic case. A modified RPR model is developed in which (i) the double-counting problems are eliminated, and (ii) direct-channel resonances are described in terms of their Regge-trajectory functions. There is no difficulty with the tails of the resonant amplitudes in this formulation of the RPR model. Moreover, the contributions of the entire set of resonances on a given Regge trajectory can be included in the scattering amplitude. The relevance of these modifications of the RPR model to past analysis of πN scattering is discussed briefly. (auth)

20233 RADIATIVE pp-PAIR ANNHILATION. Gadzhiev, S. A. (Azerbaydzhan State Univ., Baku). Dokl. Akad. Nauk Azerb. SSR, 23: No. 10, 3-7(1967). (In Russian).

Calculations of processes with hadron participations are complicated due to the lack of consequent theory of strong interactions. Previously some concrete cases of strong interactions were considered either phenomenologically or by introducing form factors. An attempt was made to consider the processes by calculating the cross sections of the processes: $p + \bar{p} \rightarrow K_1^0 + K_2^0 + \gamma$ and $p + \bar{p} \rightarrow \pi^+(K^+) + \pi^-(K^-) + \gamma$ considering strong interactions in the initial and final stages. The matrix element for the $p + \bar{p} \rightarrow B^+ + B^- + \gamma$ was determined (B is spinless boson). The diagram of spinless boson formation in proton-antiproton formation is given. The examined cases showed that the scheme of $\bar{p}p \rightarrow \pi^+\pi^-\gamma$ is the most probable in the annihilation of low-energy $\bar{p}p$-pairs. (R.V.J.)

20234 RISING MESON TRAJECTORIES. Epstein, G.; Kaus, P. (Univ. of California, Riverside). Contract AT(11-1)-34P107A. Phys. Rev., 166: 1633-7(Feb. 25, 1968).

An integral equation for rising meson Regge trajectories is derived and solved for the ρ trajectory. The equation is a simple extension of a method previously described in which dispersion relations for $\alpha(s)$ and the reduced residue b(s) are coupled by unitarity. In the present method, the trajectory dispersion relation is subtracted twice, which causes trajectories to rise ~s. The solutions depend on two parameters and represent almost straight trajectories with imaginary parts. (auth)

20235 CORRECTIONS TO ρ DOMINANCE AND POLE DOMINANCE OF THE DIVERGENCE OF THE AXIAL-VECTOR CURRENT. Michael, C. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev., 166: 1826-7(Feb. 25, 1968).

A superconvergence assumption about the matrix elements is used to discuss corrections to one-meson dominance of a current or its divergence. The deviation of the observed ρ leptonic branching ratio from the ρ-dominance prediction and the correction to the Goldberger–Treiman relation are evaluated, and other predictions of the model are discussed. (auth)

20236 PRODUCTION AND DECAY OF THE h MESON. Pakvasa, S.; Tuan, S. F. (Univ. of Hawaii, Honolulu). Phys. Rev. Lett., 20: 632-4(Mar. 18, 1968).

The salient properties and the implications of the existence of the meson (h) are examined. The discussion is restricted to the more prominent one-particle-exchange processes for the production of h including $K^- + p$, $\pi^- + p$, and $\bar{p} + p \rightarrow h^0 + \rho^0$ interactions. The various decay modes of the meson (h) are discussed. Implications for CP nonconservation are also considered. (J.F.P.)

20237 MESON BOOTSTRAP WITH FINITE-ENERGY SUM RULES. Schmid, Christoph (Univ. of California, Berkeley). Phys. Rev. Lett., 20: 628-31(Mar. 18, 1968). (UCRL-18009).

It is shown how resonances in the direct $\pi\pi$ channel (ρ, f, g) generate (via FESR) the ρ Regge pole in the t channel, and $\alpha_\rho(t)$ is calculated for α from $-\frac{1}{2}$ to +3. This is relevant to the question of elementarity versus compositeness of particles. If it is assumed that the $I_t = 1$ amplitude is dominated by one Regge pole, the ρ, then the model predicts that this pole is moving, with $d\alpha/dt \approx 1.0\ GeV^{-2}$, and it cannot be a fixed Regge pole (elementary particle). Also the superconvergent $I_t = 2$ and the I = 0 amplitudes (with P and P'), and the ρ–f bootstrap system is solved. (J.F.P.)

20238 HEAVY BOSONS, REGGE TRAJECTORIES AND DYNAMICAL THEORIES. Collins, P. D. B.; Johnson, R. C.; Squires, E. J. (Univ. of Durham, Eng.). Phys. Lett., 26B: 223-5(Jan. 22, 1968).

It is argued that the narrowness of the higher boson resonances, R, S, T and U, is incompatible with the bootstrap hypothesis if these resonances are regarded as lying on straight Regge trajectories passing through the ρ and A_2. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 20173, 20222, 20751, 20752, 20754, 20755, and 20770.

20239 (ITF-67-47) RELATIVISTIC-INVARIANT MODELS OF BARYONS REGARDED AS COMPOSITE PARTICLES. I. Shelest, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 32p. Dep.

The relativistic matrix elements of baryon currents are determined in the framework of the quasi-independent quark model. The existence of an algebra of these matrix elements taken to first order in the inverse matrix of the baryon is demonstrated. (auth)

20240 JET ANALYSIS BY THE METHOD OF PRINCIPAL AXIS. Danysz, M.; Wojcik, W. (Inst. of Nuclear Research, Warsaw. Univ. of Warsaw). Acta Phys. Pol., 33: 81-7(Jan. 1968).

The analysis of six prong jets in 8-GeV/c π^+p interactions by the method of principal axis does not show the existence of well-separated bodies which could be identified as the known resonances. The shape of the jets does not show the significant flatness. (auth)

20241 POLARIZATION PARAMETERS AND RESONANCE DECAY DISTRIBUTIONS IN HIGH-ENERGY TWO-BODY PROCESSES. II. MESON-BARYON COLLISIONS. Golab, Z.; Kotanski, A. (Jagellonian Univ., Krakow). Acta Phys. Pol., 33: 51-62(Jan. 1968).

The polarization and resonance decay parameters of several familiar meson-initiated two-body processes are expressed in terms of the transversity amplitudes. The problem of finding all the amplitudes (together with their relative phases) from the quantities which are directly measurable is discussed in each case. (auth)

20242 DETERMINATION OF THE SCATTERING AMPLITUDE FROM THE KNOWLEDGE OF ITS MODULUS ABOVE THRESHOLD. Odorico, R. (Univ., Trieste, Italy). Nuovo Cim. (10), 54A: 96-107(Mar. 1, 1968).

Dispersion relations at fixed momentum transfer are presented from which the scattering amplitude may be determined once one knows its modulus above s- and u-channel thresholds. As unknown parameters, instead of the subtraction and coupling constants, appear the positions of the zeros of the amplitude. From a rough knowledge of the phase of the amplitude in the physical region the number of the latter may be determined. In π^+p forward elastic scattering for instance the so determined number of unknown parameters is two, as in the usual dispersion relations. Phenomenological applications are discussed. (auth)

20243 SUM RULES IN COUPLING CONSTANTS BY FIELD-THEORETIC METHODS. Bose, S. K. (Indian Inst. of Tech., Kanpur). Nuovo Cim. (10), 54A: 174-8(Mar. 1, 1968).

The Gell-Mann-Okubo mass formula and sum rules for baryon-meson coupling constants are derived by field theoretic methods in broken SU_3. (auth)

20244 PRODUCTION OF RESONANCES IN πN AND KN COLLISIONS AND THE REGGE POLES. Kaidalov, A. B.; Karnakov, B. M. (Inst. of Theoretical and Experimental Physics, Moscow. Moscow Engineering-Physics Inst.). Yadern. Fiz., 7: 152-65 (1968). (In Russian).

In framework of the Regge-pole model the production of resonances in πN and KN collisions at high energies is considered. Comparison with available experimental data is carried out. It is shown that the behavior of the differential cross sections and of the density matrix elements for resonances is in reasonable agreement with predictions of the Regge-pole model. The role of branching points in the complex j plane is discussed. The fulfilled analysis indicates that the contribution from the branching points without any definite purity is small in the energy region $\lesssim$10 GeV. (auth)

20245 RECONSTRUCTION OF THE FORWARD SCATTERING MATRIX AMPLITUDES. Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 178-82(1968). (In Russian).

Comparison with the dispersion relations, sum rules, etc. requires the reconstruction of the amplitudes of meson-nucleon, NN and γN forward scattering. Formulas necessary for this procedure at $\theta = 0°$ are obtained. (auth)

20246 ON THE POSSIBILITY OF MEASUREMENT OF THE ISOBAR Δ^{++} (1236) MAGNETIC MOMENT IN RADIATIVE π^+p-SCATTERING. Kondratyuk, L. A.; Ponomarev, L. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 7: 111-19(1968). (In Russian).

A method for the measurement of the isobar Δ^{++} (1236) magnetic moment in the process $\pi^+p \to \pi^+p\gamma$ is shown. The differential cross section of this process at the energy of incident π-meson close to resonant for γ-quanta emitted at large angles θ_1 and θ_2 relative to the directions of both π-mesons, is obtained. It is shown that the presence of the magnetic moment of Δ^{++} may alter the $d\sigma/d\omega$ in the interval of γ-quanta energy 30 MeV $< \omega < \omega_{max}$ and in the interval of $135 < \theta_{1,2} < 180°$ nearly twice if $\mu_\Delta = 2\mu_p$ as it is predicted by the SU (6)-symmetry. The ratio $d\sigma/d\omega$ itself in this domain $\sim 10^{-30}$ cm^2/100 MeV. The background is also estimated. (auth)

20247 DISPERSION SUM RULES AND THE πN SCATTERING AT LOW AND HIGH ENERGIES. Zhuravlev, V. I.; Meshcheryakov, V. A.; Rerikh, K. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 136-43(1968). (In Russian).

Dispersion sum rules for parameters of the πN scattering at low and high energies are obtained on the basis of the Cauchy theorem. The results are compared with the experimental data. (auth)

20248 CUTS IN THE COMPLEX l-PLANE AND INELASTIC CROSS SECTIONS. Tao Wong Tyk; Nguyen Van Hieu; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 166-9(1968). (In Russian).

The contribution of cuts in the complex l-plane is essential in the inelastic processes: $K + p \to K + \pi + p'$ (p' is an isobar with negative parity). This assumption is confirmed by experimental data. (auth)

20249 REGGE-POLE ANALYSIS OF BACKWARD PEAKS IN ELASTIC PION-PROTON SCATTERING. Noirot, Y.; Rimpault, M.; Saillard, Y. (Faculte des Sciences, Bordeaux). Phys. Lett., 26B: 454-6(Mar. 4, 1968).

High-energy $\pi^\pm p$ scattering is analyzed in the range $-u \lesssim 0.2$ in terms of the exchange of the N and Δ Regge trajectories. In both cases the characteristic features are rather well reproduced. The parameters corresponding to these trajectories are determined. (auth)

20250 ZERO MASS PIONS AND PION-NUCLEON SCATTERING. Hamilton, J. (NORDITA, Copenhagen). pp 159-86 of Proceedings of the Liperi Summer School in Theoretical Physics, 1967. Helsinki, University of Helsinki, 1967.

A new derivation of four results in $\pi + N$ scattering theory is given. These results are obtained by considering zero-mass pions. They are the S-wave $\pi + N$ scattering length relation, Adler's consistency relation for $A^{(+)}$, the G_A Adler-Weisberger sum rule, and the relation for the meson coupling constant G_π^2. The problem of continuation in the pion mass is discussed in order to compare these results with the experimental values, and in this connection it is also shown how these relations lead to the $T^{(-)}\pi + N$ amplitude at threshold. A nonrelativistic model for very low-energy $\pi + N$ scattering is also discussed. (J.F.P.)

20251 A NOTE ON THE REAL TO IMAGINARY RATIO OF THE π^-p CHARGE EXCHANGE SCATTERING AMPLITUDE AT HIGH ENERGIES. Kanazawa, Akira (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto), 38: 1408-9(1967).

It is argued that the relation $\lim_{s\to\infty}$ [Re f(s,t)/Im f(s,t)] = tan [$\pi\alpha(t)/2$] for the $\pi^- + p$ charge exchange scattering does not require the analyticity with respect to the complex angular momentum or even to the momentum transfer squared. The only assumptions needed are the asymptotic behavior of the amplitude f(s,t), the crossing symmetry and the real part, and the analyticity property in the complex s plane. (J.F.P.)

20252 REGGE-POLE COUPLINGS TO NUCLEONS IN A FIELD-THEORY MODEL. Swift, Arthur R. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 166: 1621-8(Feb. 25, 1968). (COO-881-119).

Perturbation theory is used to consider the coupling of both normal- and abnormal-parity Regge poles to nucleons. The kinematic dependence of the residue functions on the trajectory function is obtained. All spin-flip amplitudes have fixed poles in both the angular momentum and energy variables. One of the abnormal parity trajectories satisfies a conspiracy condition corresponding to Freedman and Wang's class II. The daughter pole in this case moves exactly parallel to the leading trajectory, unlike the daughter arising from unequal-mass kinematics. (auth)

20253 REGGE-POLE MODEL WITH L-S COUPLING. Barmawi, M. (Univ. of Chicago). Phys. Rev., 166: 1846-56(Feb. 25, 1968).

A Regge-pole model for $PN \to P'N$ and $PN \to VN$ is proposed. The model is based on the L-S coupling scheme and describes the coupling of the particles involved in the reaction to the trajectory having definite quantum numbers J^{PC}. The scheme determines the structure of the amplitude, which in turn characterizes the decay density matrix of the produced resonance. Kinematical factors and the threshold behavior are discussed on the basis of the analyticity assumption. (auth)

20254 FINITE-ENERGY SUM RULES AND THEIR APPLICATION TO πN CHARGE EXCHANGE. Dolen, R.; Horn, D.; Schmid,

C. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 166: 1768-81(Feb. 25, 1968). (CALT-68-143).

The finite-energy sum rules are derived and discussed, which form consistency conditions imposed by analyticity on the Regge analysis of a scattering amplitude. Their finite form makes them particularly useful in practical applications. The various applications are discussed, emphasizing a new kind of bootstrap predicting the Regge parameters from low-energy data alone. The methods are applied to πN charge exchange and are able to derive many interesting features of the high-energy amplitudes at various t. In particular, the existence of zeros of the amplitudes and of additional ρ poles is established. On the basis of the finite-energy sum rules and the analysis of the πN amplitudes, theoretical and experimental evidence that double counting is involved in the interference model is presented, which adds direct-channel resonances to the exchanged Regge terms. (auth)

20255 SUBTRACTED DISPERSION RELATIONS AND ON-MASS-SHELL CURRENT ALGEBRA: PSEUDOSCALAR-MESON–BARYON SCATTERING LENGTH. De Rujula, A.; Mateev, M.; Swiecki, M. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., 166: 1727-31(Feb. 25, 1968).

An explicit form of the source of the pseudoscalar meson field, consistent with the hypothesis of partially conserved axial-vector current, is proposed. By means of it the pseudoscalar-meson–baryon S-wave scattering lengths are calculated. A close connection between the equal-time commutators of currents and the subtraction constants in dispersion relations of amplitudes is shown to exist. (auth)

20256 DIRECT-CHANNEL RESONANCES FROM REGGE-POLE EXCHANGE. Schmid, Christoph (Univ. of California, Berkeley). Phys. Rev. Lett., 20: 689-91(Mar. 25, 1968). (UCRL-18048).

The ρ Regge amplitude for πN charge-exchange scattering with helicity flip is partial-wave analyzed in the direct channel. This produces resonance circles on the Argand diagram corresponding to the prominent experimental N* resonances. (auth)

20257 DETERMINATION OF THE KNY COUPLING CONSTANTS USING MODIFIED DISPERSION RELATIONS. Chan, C. H.; Meiere, F. T. (Purdue Univ., Lafayette, Ind.). Phys. Rev. Lett., 20: 568-71(Mar. 11, 1968).

The KNY coupling constants are determined using a new procedure which includes a criterion for checking the self-consistency of the necessary extrapolation into the unphysical region. (auth)

20258 POLARIZATION IN $\pi^-p \to \eta n$ AND THE RATIO OF F TO D COUPLING OF N_γ (2650). Yokosawa, A. (Argonne National Lab., Ill.). Phys. Rev. Lett., 20: 566-8(Mar. 11, 1968).

The results of recent polarization measurements in the reaction $\pi^-p \to \eta n$ at intermediate energies are explained by using a simple interference model. A possible determination of the ratio of F to D coupling of $N_\gamma(2650)$ is discussed and the conclusion drawn is unaffected in spite of the ambiguity regarding the sign of the A_2 residue associated with the spin-flip amplitude. (auth)

20259 UNITARITY CORRECTIONS TO LOW-ENERGY PARAMETERS IN SOFT-PION CALCULATIONS. Bhargava, S. C.; Biswas, S. N.; Gupta, K. C.; Datta, K. (Univ. of Delhi). Phys. Rev. Lett., 20: 558-60(Mar. 11, 1968).

The results of soft-pion current-algebra calculations of low-energy parameters for s-wave pion-nucleon scattering in the $I = \frac{1}{2}$ channel, are unitarized using the N/D formalism. Corrections arising from unitarity, off-shell kinematics, and off-shell dynamics are clearly unitarized. (auth)

20260 SPACE-TIME SHIFTS AND CROSS-SECTIONS IN COLLISIONS BETWEEN RELATIVISTIC WAVE PACKETS. Olkhovsky, V. S.; Recami, E. (Univ., Milan). Nuovo Cim. (10), 53A: 610-24(Feb. 1, 1968).

A study is made of motion and collision of relativistic wave packets. Starting from space-time definitions of the experimental observables (cross-sections, space-time shifts, etc.), their expressions are obtained in the energy-momentum representation, by using some Fourier-transformation techniques, thus generalizing some previous (nonrelativistic) results to the case of two relativistic spin-zero interacting particles. It is noticed that wave-packet spreading is often very large and cannot be neglected, but at the same time it is shown that the observable quantities do not commonly depend on spreading, blending or "smoothing." As an application the time duration of some interactions are calculated at different energies. (auth)

20261 PHENOMENOLOGICAL ANALYSIS OF $I = \frac{1}{2}$ SINGLE-PION PRODUCTION PROCESSES IN THE ENERGY RANGE 500 TO 700 MeV. Morgan, D. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev., 166: 1731-59(Feb. 25, 1968).

Single-pion production processes in the energy range 500 to 700 MeV are discussed. It is assumed that production occurs in the partial waves S_1, P_1, P_3, and D_3 for $I = \frac{1}{2}$ and $\frac{3}{2}$ via isobar formation in a generalized sense. Isobars treated are the $N^*(1236)$ and the low-energy tails of the σ (assumed to be a broad resonance centered at 700 MeV) and the ρ. Emphasis is placed on maintaining consistency with the results of elastic phase-shift analyses. It is suggested that the major contributor to the charge channel $\pi^0\pi^-p$ at and above 550 MeV is P_{11} decaying via ρN. It is noted that a second P_{11} resonance occurring in the range 600 to 800 MeV would explain several phenomena. It is indicated that D_{13} very probably decays to σN as well as πN^*. A plea is entered for the presentation of future data in the form of a full production-angular-distribution analysis over the Dalitz plot. (auth)

20262 NONFORWARD $N\pi$ SUPERCONVERGENCE RELATIONS. Rivers, R. J. (Imperial Coll. of Science and Tech., London). Phys. Rev., 166: 1841-3(Feb. 25, 1968).

It is shown that with suitable assumptions an approximate solution to the $N\pi$ superconvergence relation exists for all values of momentum transfer in an approximation in which the relation is saturated by four Regge trajectories. This solution gives the $N\pi$ partial widths of the resonances along these trajectories as negative exponentials of a monotonically increasing function of the resonance spin J. The initial assumptions are interpreted when this monotonic function takes a simple form (power behavior). Despite the simplifying assumptions made, the solution is roughly compatible with the experimental data. (auth)

20263 REGGE BRANCH POINTS AND THE REACTIONS $\pi^-p \to K^+\Sigma^-$ AND $K^-p \to \pi^+\Sigma$. Michens, Ronald Elbert (Vanderbilt Univ., Nashville). Phys. Rev., 166: 1844-5(Feb. 25, 1968).

It is shown that the contribution to the scattering amplitude coming from a branch point in the complex angular momentum plane has a characteristic energy dependence which is determined by the branch-point trajectory $\alpha_c(t)$. However, the phase will not be related to $\alpha_c(t)$ in as simple a manner as in the case of a Regge pole. It is also shown that in the exchange of a single Regge branch point a finite polarization can be obtained. The double-charge-exchange reactions $\pi^-p \to K^+\Sigma^-$ and $K^-p \to \pi^+\Sigma^-$ are considered, and it is concluded that an investigation of these reactions at high energies would be very useful in the determination of the analytic structure of the Regge-cut amplitude. (auth)

20264 APPLICATION OF A REGGE-POLE MODEL TO THE REACTION $\pi^-p \to \pi^0n$, $\pi^-p \to \eta n$, AND $\pi^+n \to \omega p$. Barmawi, M. (Univ. of Chicago). Phys. Rev., 166: 1857-62(Feb. 25, 1968).

A Regge-pole model with L-S coupling is considered for the reactions $PN \to P'N$ and $PN \to VN$. The model is used to analyze the processes $\pi^-p \to \pi^0n$, $\pi^-p \to \eta n$, and $\pi^+n \to \omega p$. Good agreement is obtained for the momentum-transfer distribution. The density matrix of the ω meson agrees qualitatively with the available data. (auth)

20265 STUDY OF THE REACTION $\pi^-p \to \pi^+\pi^-n$ AT AN INCIDENT ENERGY OF 870 MeV. Banner, M. (Centre d'Études Nucleaires de Saclay, Gif-sur-Yvette, France); Detoeuf, J. F.; Fayoux, M. L.; Hamel, J. L.; Zsembery, J.; Cheze, J.; Teiger, J. Phys. Rev., 166: 1346-53(Feb. 25, 1968).

In the reaction $\pi^-p \to \pi^+\pi^-n$, the π^+ momentum spectrum was measured at various angles, from which the distributions $(d^2\sigma/dMd\Omega)^*$ of the π^-n system were deduced. These distributions are compared with those obtained from a phenomenological model. This comparison allows a determination of the amplitude of the inelastic waves. It is found that the resonant waves D_{15} and F_{15} are not strongly coupled to the channel $\Delta(1238) + \pi$. (auth)

20266 REGGEIZED $\pi\rho$ MASS ENHANCEMENT IN THE A_1 REGION. Berger, Edmond L. (Univ. of California, Berkeley. Dartmouth Coll., Hanover, N. H.). Phys. Rev., 166: 1525-7 (Feb. 25, 1968). UCRL-17825(Rev.)

Mass distributions for the $\pi\rho$ final state in the reaction $\pi N \to \pi\rho N$ are calculated from a Regge-pole-exchange model. Compared with the results of the Drell-Deck-type models, significantly increased $\pi\rho$ mass peaking in the A_1 region is predicted; calculated widths are consistent with results of recent experiments on the A_1. (auth)

20267 FERMION TRAJECTORY PARAMETRIZATION AND SUPERCONVERGENCE. Ramachandran, R. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., 166: 1528-31(Feb. 25, 1968).

A parametrization of the nucleon and Δ trajectory is given, using both the position and the width of the resonances in a dispersion relation. The nucleon trajectory requires and accommodates a D-wave πN resonance in the neighborhood of 1670 MeV. Another significant outcome of the scheme is that the Δ trajectory has an intercept, at $W = 0$, of -0.69 and hence leads to a superconvergence relation for π^-p scattering invariant amplitudes in

the nearly backward direction (u = 0). The resulting sum rules are satisfied only if there exists a strong attractive s-wave interaction (for example, a σ meson) or other equivalent effects (such as an f meson) in the $\pi\pi \rightarrow N\bar{N}$ channel. (auth)

20268 GENERALIZED POTENTIAL FOR THE PION–NUCLEON SYSTEM. Vasavada, Kashyap V. (Univ. of Connecticut, Storrs. Goddard Space Flight Center, Greenbelt, Md.); Nath, Pran. Phys. Rev., 166: 1532-8(Feb. 25, 1968).

The problem of obtaining the generalized potential in the physical region for a given partial wave from the experimentally known phase shifts for that channel is examined. The πN system is considered, where the phase shifts are now well known up to reasonably high energies in various partial waves, and the generalized potentials for the P_{33}, P_{11}, and D_{13} partial waves are computed. These generalized potentials obtained from the experimental phase shifts turn out to be rather insensitive to the asymptotic behavior of the phase shifts. The results are compared with generalized potentials obtained by the elementary-particle exchanges and also with those obtained by imposing the correct Regge asymptotic behavior. The single-particle exchange potential is in good agreement with the "experimental" value for the P_{33} channel, while for the P_{11} and D_{13} channels the single-particle exchange potentials do not reproduce the potentials computed from the phase shifts. (auth)

20269 S-WAVE π–N SCATTERING LENGTHS, CURRENT ALGEBRA, AND ρ + ρ′ DOMINANCE. Moffat, J. W. (Univ. of Toronto). Phys. Rev. Lett., 20: 620-3(Mar. 18, 1968).

Various predictions of the $\rho\pi\pi$ coupling constant $f_\rho^2/4\pi$ are discussed. A ρ + ρ′ meson dominance model is considered with $M_{\rho'} \simeq 1600$ MeV and $\Gamma_{\rho'} \simeq 200$ MeV. This model predicts a value of the S-wave π–N scattering length formula $\alpha_1 - \alpha_3$ in better agreement with experiment than the ρ-dominance model when $\Gamma_\rho = 128$ MeV, and the modified Kawarabayashi-Suzuki-Riazuddin-Fayyazuddin relation is well satisfied. (auth)

20270 PARITY DOUBLING, ASYMMETRIC FERMION TRAJECTORIES, AND LOW-ENERGY πN DYNAMICS. Lyth, D. H. (Univ. of Lancaster, Eng.). Phys. Rev. Lett., 20: 641-3(Mar. 18, 1968).

It is suggested that fermion Regge trajectories are strongly asymmetric functions of w (mass) for $w \lesssim 1$ GeV, in contrast to a recent suggestion of Barger and Cline. This suggestion fits the observed spectrum of πN resonances and would also be predicted by conventional low-energy πN dynamics. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 20245.

20271 (JINR–E1-3707) UNAMBIGUOUS PHASE SHIFT ANALYSIS OF NUCLEON–NUCLEON SCATTERING AT 400 MeV AND THE ENERGY DEPENDENCE OF PHASE SHIFTS ABOVE THE PION PRODUCTION THRESHOLD. Yanout, Z.; Kazarinov, Yu. M.; Legar, F.; Rozanova, A. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 34p. Dep.

The phase shift analysis of nucleon-nucleon scattering data at energies near 400 MeV was performed. The search for the solutions of the phase shifts was carried out for the maximal orbital momentum $l_{max} = 4$. Only the $^1D_2$ wave is assumed to have an immaginary part. Seven solutions were obtained in the region $\chi^2 \leq 1.5\ \chi^{-2}$. A detailed investigation has shown, that six of them can be rejected with the probability of Type I error smaller than 0.59%. Tables of phase shifts and the angular dependences of the experimental quantities are given. The energy dependences of phase shifts in the region 10 to 630 MeV are shown in the graphs. (auth)

20272 (JINR-P1-3702) AMPLITUDY UPRUGOGO NN-RASSEYANIYA V SOSTOYANIYAKH S IZOTOPICHESKIM SPINOM T = 0 I T = 1. (Elastic N-N Scattering Amplitudes in the States With the T = 0 and T = 1 Isotopic Spins). Golovin, B. M.; Rozanova, A. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 29p. (In Russian). Dep.

The amplitudes of the elastic nucleon-nucleon scattering in the states with T = 0 and T = 1 isotopic spins were calculated for a number of energies in the region 23 to 630 MeV. The calculations were made according to the data of the previously published phase shift analysis. (auth)

20273 POLARIZATION PARAMETERS AND RESONANCE DECAY DISTRIBUTIONS IN HIGH-ENERGY TWO-BODY PROCESSES. I. BARYON–BARYON COLLISIONS. Golab, Z.; Kotanski, A. (Jagellonian Univ., Krakow). Acta Phys. Pol., 33: 37-50(Jan. 1968).

The cross sections, polarization parameters and resonance decay distributions for the simplest types of two-body reactions are expressed in terms of independent transversity amplitudes. Crossing relations are explicitly written down for each type of process. Implications of discrete symmetries are taken into account. The case of a polarized target is also considered. Finally, the discussion of the number of independent parameters, which can be found by performing various measurements, is presented for each reaction. (auth)

20274 NUCLEON–HYPERON SCATTERING IN A MULTICHANNEL FORMALISM. Letessier, J.; Tounsi, A. (Institut de Physique Nucleaire, Paris). Nuovo Cim. (10), 54A: 67-78(Mar. 1, 1968).

In the framework of the one-boson exchange model differential and total cross sections were calculated for the following processes: ΛN → ΛN, ΛN → ΣN, ΣN → ΣN. Special attention is paid to the coupling of different channels, treated in the ND^{-1} formalism. The parameters are fixed by SU_3 symmetry except for the ω and the σ. A reasonable fit with experimental results is obtained. (auth)

20275 PARTIAL-WAVE SCATTERING AMPLITUDES FOR VELOCITY-DEPENDENT POTENTIALS. II. ASYMPTOTIC BEHAVIOUR FOR LARGE ENERGY. LEVINSON THEOREM AND THE N/D METHOD. Butera, P.; Girardello, L. (Univ., Milan). Nuovo Cim. (10), 54A: 141-54(Mar. 1, 1968).

A method devised by Langer, slightly different from the one used previously is applied to the study of the asymptotic behavior, for large complex energy, of the partial-wave scattering amplitudes a(λ,s) in the case of the velocity-dependent potential $V(x,p) = V_0(x) + \frac{1}{2}((p^2/2M)\ V_1(x) + V_1(x)(p^2/2M))$, where $V_0(x)$ and $V_1(x)$ are suitable superpositions of Yukawa potentials. It is shown that the a(λ,s) have an essential singularity at infinity. The Bargmann theorem and an extended Levinson theorem hold, and a generalized N/D method is feasible. The S-wave equation for a simple, but physically meaningful, example is explicitly solved. (auth)

20276 PARTIAL-WAVE SCATTERING AMPLITUDES FOR VELOCITY-DEPENDENT POTENTIALS. I. ANALYTICITY PROPERTIES IN THE ENERGY- AND ANGULAR-MOMENTUM VARIABLES. ASYMPTOTIC BEHAVIOUR FOR LARGE ANGULAR MOMENTUM. Butera, P.; Girardello, L. (Univ., Milan). Nuovo Cim. (10), 54A: 127-40(Mar. 1, 1968).

A systematic survey of the analyticity properties and the asymptotic behavior in λ and in k of the partial-wave scattering amplitudes a(λ,k) related with the velocity-dependent potential $V(x,p) = V_0(x) + \frac{1}{2}((p^2/2M)\ V_1(x) + V_1(x)(p^2/2M))$, where $V_0(x)$ and $V_1(x)$ are suitable superpositions of Yukawa potentials is given. The analyticity properties in λ and k of a(λ,k) are derived and, by an investigation of the asymptotic behavior of a(λ,k) as λ tends to infinity, for fixed positive energy, the feasibility of the Watson–Sommerfeld transformation is proved. (auth)

20277 FORWARD NN AND $N\bar{N}$ CHARGE-EXCHANGE SCATTERING AT HIGH ENERGY. Gauron, P.; Lacombe, M. (Institut de Physique Nucleaire, Orsay, France). Nuovo Cim. (10), 54A: 203-8(Mar. 1, 1968).

For the discussion of the NN and NN charge exchange scattering at high energy it is supposed, in a first step, that the meson (ρ′), previously introduced, exists. Solutions are found consistent either with evasion or conspiracy. But if the ρ′ parameters are made consistent with those deduced from πN and KN scattering, the necessity of a conspiracy is found. On the other hand, instead of the ρ′ the possibility of a ρ P cut is considered. Although rather crude approximations are used, it seems impossible to fit the forward differential cross sections without the help of conspiracy, either of the cut with itself or between poles. Good results were obtained in the second case with a pole A_1 such that $\alpha_{A_1}(0) = -0.2$. But a self-conspirating cut can not be excluded. (J.F.P.)

20278 APPLICATION OF THE FADDEEV EQUATIONS TO THE DETERMINATION OF THE NEUTRON–NEUTRON LOW-ENERGY PARAMETERS. Fontannaz, M. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim. (10), 53B: 53-62(Jan. 11, 1968).

The Faddeev equations are used in the framework of separable approximation in order to determine the parameters of the neutron-neutron system at low energy from the doublet neutron-deuteron scattering length a_2. The sensitivity of the 3-body results to the parameters of the 2-body T-matrices is exhibited and it is shown that a good value (0.7 fm) of the doublet n-d scattering length a_2 may be obtained if we use an n-n interaction characterized by $a_{nn} = -16.25$ fm and $r_{0nn} = 3.79$ fm. Simultaneously a good value of the binding energy (E = 8.77 MeV) is obtained. (auth)

20279 DIFFRACTION MODEL FOR HIGH-ENERGY pp SCATTERING. Durand III, Loyal; Lipes, Richard (Univ. of

Wisconsin, Madison). Phys. Rev. Lett., 20: 637-40(Mar. 18, 1968).

The asymptotic limit of the pp scattering cross section is considered using a diffraction-scattering model. The calculated differential cross section displays diffraction zeros, which at present energies should be filled in by the real part of the pp scattering; the pp polarization should also show considerable structure. It is shown that the high-energy, large-momentum-transfer hadron-hadron scattering amplitude is proportional in this model to a product of hadron form factors. (auth)

20280 INTERPRETATION OF THE (p,pd) REACTION AT 1 BeV. Pugh, H. G. (Univ. of Maryland, College Park). Phys. Rev. Lett., 20: 601-2(Mar. 18, 1968).

It is pointed out that the experiment Sutter et al. (Phys. Rev. Letters 17: 827(1966)) on the quasifree scattering of 1-GeV protons from neutron–proton pairs in nuclei presents no evidence for short-range correlations in the nuclear wave function. On the contrary, a first-order interpretation is not only possible but plausible without them. Because of this any extraction of quantitative information about the short-range correlations is difficult and can come only after a theory is shown to be correct in first order. (J.F.P.)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 20106, 20343, 20543, and 20653.

20281 (INP-555/PH, pp 141-53) ALGEBRAIC FORMULATIONS OF DYNAMICAL THEORIES OF THE COMPOSITE SYSTEMS WITH MASS SPLITTING. Olszewski, Jan (Jagellonian Univ., Krakow (Poland). Inst. of Physics).

The main ideas and results of previous work of Fronsdal concerning the construction of the field theory with an infinite number of components, consideration of some relativistic wave equations with various mass spectra, and transformation of the nonrelativistic theory of the hydrogen atom into the form of the local infinite-component field theory. Some representations of the SO(p,1) algebras, the Fronsdal results on infinite-component field theory, and wave equations with mass splitting are covered. (J.F.P.)

20282 QUANTUM NUMBERS IN THE LITTLE GROUPS OF THE POINCARE GROUP. Winternitz, P.; Lukach, I.; Smorodinskii, Ya. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 192-201(1968). (In Russian).

Integrals of motion and quantum numbers in the groups 0(3), 0(2,1), and E_2 are considered. It is shown that to any separable coordinate system for Laplace's equation an integral of motion corresponds that is a homogeneous Hermitian operator — polynomial, bilinear in the generators of the corresponding group. Any operator of the considered type is equivalent to one of the obtained polynomials. (auth)

20283 FIELD THEORY WITH INFINITE MULTIPLETS IN THE SU(2,2) SYMMETRY. Chi, Cao (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., 33: 3-12(Jan. 1968).

Two series of degenerate unitary representations of the group SU(2,2) (the principal and the supplementary ones) were found previously. The reduction $SU(2,2) \supset \{SU(2) \otimes SU(2) \otimes U(1)\}_p$ where p is the four-momentum of particles and the classification of particles according to the irreducible representations of the maximal compact subgroup were also given. The vertex of the interaction of an infinite multiplet with a singlet field is considered. The expression of a "unique propagator" of an infinite boson and fermion multiplet is given. The true propagator of a particle with definite spin can be obtained from the "unique propagator" with the help of projection operators. Besides it is shown by using the "unique projection" that in many cases the field theory with infinite multiplets leads to convergent diagrams while they are divergent in the conventional field theory. (auth)

20284 FEYNMAN DIAGRAMS FOR UNITARY REPRESENTATIONS OF $SL_{2,C}$. Koller, K. (Imperial Coll. of Science and Tech., London). Nuovo Cim. (10), 54A: 79-95(Mar. 1, 1968).

Weinberg's derivation of Feynman rules for finite-dimensional representation of the Lorentz group is generalized for massive particles to infinite-dimensional irreducible representations of the Lorentz group. Following Feldman and Matthews, local and causal infinite-dimensional fields, quantized by a commutator, are written down for irreducible unitary representations of the principal series of $SL_{2,C}$. Feynman rules for those infinite-dimensional fields are stated and three-point functions and pole diagrams are given explicitly for arbitrary unitary irreducible representations of the principal series of $SL_{2,C}$. (auth)

20285 CLASSICAL APPROACH TO BROKEN SYMMETRIES. de Mottoni, P. (Scuola Normale Superiore, Pisa, Italy); Fabri, E. Nuovo Cim. (10), 54A: 42-54(Mar. 1, 1968).

A classical model describing spontaneous breakdown is studied. Some results are derived concerning the residual invariance of the solutions, the mass spectrum and the occurrence of zero masses. They are illustrated in two examples with SO_n and SU_3 invariance. The connection with a possible quantum theoretical treatment is sketched. (auth)

20286 DYNAMICAL SYMMETRY OF THE NONISOTROPIC OSCILLATORS. Vendramin, I. (Univ., Padua). Nuovo Cim. (10), 54A: 190-2(Mar. 1, 1968).

It is found that among all the n-dimensional oscillators with frequencies at integral ratios besides the harmonic oscillator, the only ones which have the dynamical symmetry group SU(n) are those where $1:\alpha:\ldots:\alpha$. For each of them the generators of the corresponding algebra were constructed in a conceptually simple way. For the oscillators with frequencies at rational ratios ($\alpha_1 \neq 1$) the formula for the number of linearly independent eigenstates belonging to a certain level is still valid provided that certain conditions are satisfied. Therefore, it is concluded that for such oscillators too the presence of the SU(n) symmetry must be excluded. (J.F.P.)

20287 SELECTION RULES AND THE DECOMPOSITION OF THE KRONECKER SQUARE OF IRREDUCIBLE REPRESENTATIONS. Smith, P. R.; Wybourne, B. G. (Univ. of Canterbury, Christchurch, N. Z.). J. Math. Phys. (N. Y.), 8: 2434-40(Dec. 1967).

The irreducible representations occurring in the decomposition of the Kronecker squares of irreducible representations of finite and continuous groups are shown to be readily separable into symmetric and antisymmetric parts using Littlewood's method of plethysm. Particular applications of the rotation and symplectic groups, together with selection rules for isoscalar factors, are given. (auth)

20288 MASSLESS PARTICLES WITH DEFINITE HELICITY ARE NOT WEAKLY LOCALIZABLE. Galindo, A. (CERN, Geneva). Helv. Phys. Acta, 41: 257-60(Apr. 1, 1968).

The concept of localizability was recently extended and particles such as the photon were proved to be weakly localizable. This was possible, however, because both helicities were simultaneously taken into account. It is proved that massless particles with finite spin $\neq 0$ and irreducible under the (connected) Poincaré group are not weakly localizable. (auth)

20289 NEW METHOD FOR THE ANALYSIS OF UNITARY REPRESENTATIONS OF SL(n,C). Leutwyler, H.; Gorge, V. (Univ., Bern). Helv. Phys. Acta, 41: 171-94(Apr. 1, 1968).

It is shown that homogeneous variables may be used in a covariant fashion to analyze unitary as well as finite dimensional representations of the group SL(n,C). In particular the reduction of these representations with respect to the maximal compact subgroup SU(n) is carried out in an explicitly covariant manner. The method is particularly useful for degenerate representations. (auth)

20290 MASS OPERATOR IN THE UNITARY SYMMETRY. Gubar, Yu. I. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 7: 144-51(1968). (In Russian).

An operator M is introduced, that is related to the mass operator in a simple way. The assumption of the SU(2) invariance for M results in some new and known mass formulas for the SU(3) multiplets, and with the electromagnetic corrections at once taken into account. The method may be interpreted clearly. The mass relations are deduced for decuplet, octet, and nonet. A general expression for the mass operator is obtained.

20291 CROSSING MATRICES CONCERNING THE FUNDAMENTAL TRIPLET OF SU(3). Lee, Yee-yen; Lin, Shan-yeong (National Tsing Hua Univ., Taiwan). Chin. J. Phys. (Taiwan), 5: 107-33(Oct. 1967).

CG coefficients and crossing matrix of D(1,0) or D(0,1) with some IR D(p,q) of SU(3) are calculated. The crossing matrix of $\{3\} \otimes \{3^*\} \rightarrow \{3\} \otimes \{3^*\}$ is applied to test the bootstrap possibility of the quark-antiquark channel. (auth)

20292 A POSSIBILITY OF "COMPLEX UNITARY SPINS" AND AN EXTENDED PARTICLE MODEL. Hamamoto, Shinji; Tanaka, Sho (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 38: 1411-12(1967).

It is found that the essential difference in the group-theoretical structure according as the total four momentum of a system is a time-like or a space-like one comes from the fact that the internal

relativistic spin angular momentum must be defined as the little group concerning the total four momentum of the system. As a natural extension of this argument it is pointed out that a similar situation may be expected to occur also for the internal symmetry group such as the unitary symmetry, in so far as one takes the standpoint that those symmetries are derivable from the internal space–time structure of an extended particle. The argument is illustrated by the example of a simple model for the SU(2) group based on the bi-local field. (J.F.P.)

20293 INTERNAL MULTIPLICITY STRUCTURE AND CLEBSCH-GORDAN SERIES FOR THE EXCEPTIONAL GROUP G(2). Radhakrishnan, D.; Santhanam, T. S. (Inst. of Mathematical Sciences, Madras). J. Math. Phys. (N.Y.), 8: 2206-9 (Nov. 1967).

An explicit algebraic formula is obtained for the multiplicity $\overline{M}(\gamma)$ of a vector γ belonging to the fundamental domain of the group G(2). Using this, the internal multiplicity $M^m(m')$ of a weight m′ of the irreducible representation D(m) with the highest weight m is calculated through Kostant's formula for the dominant weights. The Clebsch–Gordan decomposition of the direct product of two irreducible representations is then obtained. (auth)

20294 UNITARY REPRESENTATIONS OF THE GROUP O(2,1) IN AN O(1,1) BASIS. Mukunda, N. (Syracuse Univ., N. Y.). J. Math. Phys. (N.Y.), 8: 2210-20 (Nov. 1967).

The unitary irreducible representations of the group SO(2,1), belonging to the continuous and the discrete classes are considered. They are cast into a form in which the noncompact generator of an O(1,1) subgroup is diagonal. Some properties of the remaining generators are examined on this basis. The known result that the spectrum of the noncompact generator covers the real line twice for representations of the continuous class, and once for those of the discrete class is recovered. (auth)

Applications (Electromagnetic and Weak)

20295 (CONF-670211) TALKS PRESENTED AT THE SYMPOSIUM ON THE PRESENT STATUS OF CP VIOLATION [ARGONNE, ILLINOIS], FEBRUARY 16–17, 1967. (Argonne National Lab., Ill.). 56p. Dep. CFSTI.

The conference included four papers. A separate abstract was prepared for each paper. (J.F.P.)

For abstracts of individual papers see: 20198–20200 and 20296.

20296 (CONF-670211–, pp 1-5) DISCUSSION OF THE GENERAL THEORETICAL FRAMEWORK FOR CP VIOLATION. Wolfenstein, L. (Argonne National Lab., Ill.).

The parameters involved in a theoretical treatment of the $K^0 \to 2\pi$ decay are enumerated, and the qualitative results that follow from the fact that experiments give for the amplitude ratios $|\eta_{00}| \simeq 2|\eta_{+-}|$ are indicated. It is noted that accepting the result for the rate $K_L^0 \to \pi^0 + \pi^0$ means that CP violation should be observable in decays other than those of mesons (K_2^0). (J.F.P.)

20297 ELECTRON HELICITY- AND T-INVARIANCE. Umerjee, R. K. (Texas A and M Univ., College Station). Nuovo Cim. (10), 54A: 155-63 (Mar. 1, 1968).

Electron helicity was studied in the final state in elastic e-d scattering with vector-polarized targets, where the deuteron is described by a nonrelativistic wave function with a D-state included. Also treating the problem relativistically, an additional magnetic form factor G_2 which violated T-invariance is introduced in the deuteron electromagnetic vertex. This produces an asymmetry for the electrons scattered from polarized deuterons which have no preferential direction in the scattering plane. This could provide a test for T-invariance. (auth)

20298 ELECTROMAGNETIC FORM FACTORS WITH SL(2, C). Zulauf, M. (Univ., Bern). Helv. Phys. Acta, 41: 221-38 (Apr. 1, 1968).

The Budini–Fronsdal symmetry group G = P ⊗ SL(2,C) is used to construct the production vertex of two spin–½ particles by a spin-1 particle and to calculate the appropriate form factors. The representations of the group are described by means of homogeneous variables as introduced by Leutwyler and Gorgé. The ratio of the electromagnetic form factors in the production channel is numerically computed in its full energy dependence. The result is in agreement with a formula for this ratio given by Bebié. (auth)

20299 VIOLATION OF CP INVARIANCE IN K^0 MESON DECAY AND NONEQUIVALENT REPRESENTATIONS IN QUANTUM FIELD THEORY. Grib, A. A. Vestn. Leningrad. Univ., Ser. Fiz. Khim., No. 22, 50-6 (Nov. 1967). (In Russian).

Superweak interaction of mesons K^0 breaking CP-invariance is obtained from strong interaction by means of the Bogoliubov transformation in the superfluid Bose gas theory. Different interpretations of the theory are discussed. (auth)

20300 CHIRAL DYNAMICS, FIELD-CURRENT IDENTITY, AND THE K_{l3} FORM FACTORS. Lee, Benjamin W. (State Univ. of New York, Stony Brook). Phys. Rev. Lett., 20: 617-20 (Mar. 18, 1968).

Based on the notions of chiral dynamics and the field-current identity as applied to the broken SU(3), theoretical expressions for the form factors $f_+(t)$ are obtained. A small ξ ($|\xi| \ll 1$) and a large $|\lambda_-|$ (an order of magnitude larger than λ_+) are predicted. [However, the product $\xi\lambda_-$ is expected to be small.] (auth)

20301 DISCRETE SYMMETRIES AND SU(3) IN NONLEPTONIC WEAK DECAYS AND IN ELECTROMAGNETIC DECAYS OF HADRONS. Yun, Suck-Koo. Boston, Boston Univ. Graduate School, 1967. 196p.

Thesis.

A phenomenological theory of nonleptonic weak decays which does not rely on the octet dominance and R or RP invariance is proposed. Postulating SU(3) symmetry and various discrete symmetry properties, a minimal Hamiltonian H_w is uniquely obtained in terms of a C-invariant and a C-noninvariant part respectively in such a way that the H_w is CP invariant. The C-invariant part transforms like octet members and the C-noninvariant part like decuplets, 10 and 10* members. This H_w is applied to nonleptonic hyperon decays, and all s- and p-wave amplitudes are computed in terms of fifteen reduced matrix elements, eight for s-wave amplitudes and seven for p-wave amplitudes, after applying the Wigner–Eckart theorem. The application of C-invariant properties reduced the number of reduced matrix elements to six, two for s-wave amplitudes and four for p-wave amplitudes. As a result of CP invariance, the $\Delta I = \frac{1}{2}$ rules including the SU(2) and SU(3) triangular relations among the p-wave amplitudes emerge. The relation between the A_2^0 and Σ_2^+ for s-wave amplitudes is also found. An additional assumption that the $(D/F)_{axial} = -1/\sqrt{5}$ gives the relation between the A_2^0 and Ξ^- for s-wave amplitudes which reproduces the SU(3) triangular relation for s-wave amplitudes. The same H_w is also applied to both the two-pion decays and the three-pion decays of kaons. Various sum rules are found. For the two-pion decays, it is found that K^1 decays are exclusively due to $\Delta I = \frac{3}{2}$, K^2 decays due to $\Delta I = \frac{1}{2}$, and K^1 decays due to the mixture of $\Delta I = \frac{1}{2}$ and $\frac{3}{2}$. It is also found that there is no way of relating the K^1 and K^2 decays due to the definitions of K^1 and K^2. For the three-pion decays, the effective $\Delta I = \frac{1}{2}$ rules emerge naturally. The same method is also applied to the electromagnetic decays of hadrons. The Hamiltonian H_γ is composed of the C-invariant U-scalar member of octet and the C-noninvariant U-vector members of the decuplets, 10 and 10*. The two-photon decays of π^0 and η^0, and the neutral vector meson decays are found to be effectively C-invariant electromagnetic decays, while one-photon decays of ϕ^0 and ω^0 are effectively C-violating decays. The one-photon decays of baryon resonances are mostly effectively C-invariant decays, except the N^{*0} and Ξ^{*0} decays. A possible structure of C-violating electromagnetic interactions is discussed, with the even C part transforming like the ordinary electric charge Q_I and the odd C part composed of the anomalous charge Q_K transforming like U-vectors in decuplets 10 and 10*. The various sum rules and relations are compared with experimental results whenever available. (Disser. Abstr.)

Applications (Strong)

Refer also to abstract 20230.

20302 (INP–555/PH, pp 43-71) $SU(6)_x$ GROUP AS EXTENSION OF $SU(6)_W$ TO NONCOLLINEAR PROCESSES. Ogievetskii, V. I.; Polubarinov, I. V. (Joint Inst. for Nuclear Research, Dubna (USSR)).

Although for the collinear processes there exists the relativistic $SU(6)_W$ group, which gives rather reasonable predictions, the forward or backward scattering cannot be precisely measured by experiment. There is therefore a need to obtain an extension to non-collinear processes. It is shown that a symmetry of the SU(6) type may be kept for all these processes. At the same time this symmetry is certainly a broken one; this follows from the large mass differences in multiplets. $SU(6)_x$ transformations for quarks, crossing symmetry and coordination of threelegs, classification of $SU(6)_x$ multiplets, the construction of invariant amplitudes, and the collinear case are considered. (J.F.P.)

20303 CONCEPT OF WAVE FUNCTION AND THE IRREDUCIBLE REPRESENTATIONS OF THE POINCARE GROUP. II. UNSTABLE SYSTEMS AND THE EXPONENTIAL DECAY LAW. Beskow, A.; Nilsson, J. (Inst. of Theoretical Physics, Goteborg). Ark. Fys., 34: 561-9 (1967).

The general wave function introduced in a previous article was applied to unstable particles and resonances. It was found that the different ways in which unstable particles and resonances were observed are mutually exclusive, making the notions of the two

entirely different and not just a question of some orders of magnitude in lifetime. An interesting possibility was also found, that charged track-making particles may have their lifetimes affected by the ionization density. (auth) (Sweden)

20304 BARYON–MESON VERTEX IN SL(6,C). Gorge, V.; Leutwyler, H. (Univ., Bern). Helv. Phys. Acta, 41: 195-225 (Apr. 1, 1968).

The vertex describing the coupling of the baryon octet with the pseudoscalar and vector mesons is worked out under the assumption that the coupling is invariant with respect to the semidirect product of the Poincaré group with the group SL(6,C) as proposed by Budini and Fronsdal. The resulting integral representations for the form factors in the production channel $M \rightarrow B + \bar{B}$ are evaluated numerically. (auth)

20305 NONLINEAR REALIZATIONS OF CHIRAL SYMMETRY. Weinberg, Steven (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 166: 1568-77(Feb. 25, 1968).

Possible realizations of chiral symmetry are explored, based on isotopic multiplets of fields whose transformation rules involve only isotopic-spin matrices and the pion field. The transformation rules are unique, up to possible redefinitions of the pion field. Chiral-invariant Lagrangians can be constructed by forming isotopic-spin-conserving functions of a covariant pion derivative, plus other fields and their covariant derivatives. The resulting models are essentially equivalent to those that have been derived by treating chirality as an ordinary linear symmetry broken by the vacuum, except that we do not have to commit ourselves as to the grouping of hadrons into chiral multiplets; as a result, the unrenormalized value of g_A/g_V need not be unity. The possible choices of the chiral-symmetry-breaking term in the Lagrangian according to their chiral transformation properties are classified and values of the pion-pion scattering lengths for each choice are given. If the symmetry-breaking term has the simplest possible transformation properties, then the scattering lengths are those previously derived from current algebra. An alternative method of constructing chiral-invariant Lagrangians, using ρ mesons to form covariant derivatives, is also presented. In this formalism, ρ dominance is automatic, and the current-algebra result from the ρ-meson coupling constant arises from the independent assumption that ρ mesons couple universally to pions and other particles. Including ρ mesons in the Lagrangian has no effect on the π-π scattering lengths, because chiral invariance requires that direct pion self-couplings are included which cancel the ρ-exchange diagrams for pion energies near threshold. (auth)

20306 ASYMPTOTIC SU(3), SPECTRAL-FUNCTION SUM RULES, AND THE DECAY OF THE AXIAL-VECTOR MESONS. Divakaran, P. P.; Pandit, L. K. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 166: 1782-3(Feb. 25, 1968).

A Weinberg-type sum rule [which follows from asymptotic SU(3)] for spectral functions entering the propagators of the axial-vector current densities is saturated with the 1^+ meson $A_1(1080)$ and $K_A(1320)$, and a relation is obtained between the widths of these resonances. It is found that $\Gamma(K_A \rightarrow K^*\pi) = 95$ MeV, $\Gamma(K_A \rightarrow \rho K) = 97$ MeV. (auth)

20307 REPRESENTATIONS OF THE LIE GROUP OF STRONG-COUPLING THEORY AND THE PROCEDURE OF CONTRACTION. Vaidya, S. M. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 166: 1676-80(Feb. 25, 1968).

A physically interesting representation for baryon isobars for the group of strong-coupling theory $[SU(2) \otimes SU(3)] \times T_{24}$ was obtained by Goebel and others as an induced representation. It is shown that the Goebel representation cannot be obtained by a straightforward contraction on SU(6), but that it can be obtained by contraction on $SU(2) \otimes SU(6)$. (auth)

20308 SU(3)'' EXCITATION IN BARYON RESONANCES. Greenberg, O. W.; Nelson, C. A. (Univ. of Maryland, College Park). Phys. Rev. Lett., 20: 604-7(Mar. 18, 1968).

Using the three-triplet model and the unique assignments in this model for the resonances N(1466), $Z_0(1863)$, and $Z_1(1910)$, the entire three-particle antisymmetric representation 816 of SU(18) is predicted, including the known resonances $Z_1(2190)$, $Z_1(2280)$, $N(1751)\frac{1}{2}^+$, $N(1863)\frac{3}{2}^+$, and $\Delta(1934)\frac{1}{2}^+$. The four Z resonances are predicted to have $J^P = \frac{1}{2}^+, \frac{1}{2}^+, \frac{1}{2}^+$, and $\frac{3}{2}^+$, respectively. (auth)

Field Theories

General

Refer also to abstract 20312.

20309 APPARENT SHAPE OF RAPIDLY MOVING OBJECTS IN SPECIAL RELATIVITY. McGill, N. C. (Univ. of St. Andrews, Scotland). Contemp. Phys., 9: 33-48(Jan. 1968).

A review is presented of previous work on the apparent shape of bodies travelling with speeds comparable to that of light. It is shown that the visibility or otherwise of the Lorentz contraction depends on the method of observation adopted and on the shape of the body in question. Visual, photographic and radar-type methods are discussed, including the hitherto neglected application of stereoscopic perception. The theory is developed for a new possible technique of observation, in which an object illuminates itself momentarily in its rest frame, the image being recorded as a time exposure by the observer. (auth)

Quantum Field Theory

Refer also to abstracts 20109, 20153, 20170, 20179, 20187, 20224, and 20343.

20310 (INP-555/PH, pp 183-212) ON THE ALGEBRAIC APPROACH TO QUANTUM MECHANICS AND LOCAL QUANTUM FIELD THEORY. Garczynski, W. (Wroclaw Univ. (Poland). Inst. of Theoretical Physics).

The Segal algebraic approach to quantum mechanics and the Haag–Kastler formulation of quantum field theory are briefly presented. Also a connection of the modern formulation of quantum mechanics with the formulation in terms of self-adjoint operators in the Hilbert space of states is also indicated. The algebra of observables, states of the physical system, the Gelfand–Segal construction, and the Fell theorem and the notion of physical equivalence are considered. Also discussed are the Haag–Araki and the Haag–Kastler formulations of quantum field theory. (J.F.P.)

20311 RADICAL REMOVAL OF THE CONVERGENCE DIFFICULTIES. Rayski, J. (Jagellonian Univ., Krakow). Acta Phys. Pol., 33: 129-33(Jan. 1968).

The possibility of formulating a divergence-free, relativistic, gauge invariant, and macrocausal electrodynamics is discussed. A nonlocal interaction involving a form factor dependent upon the total energy–momentum is investigated. In this formalism the four momentum is defined only implicitly and bootstraps itself. Such a theory is meaningful under some restrictions upon the quantum mechanical interpretation. The class of physically meaningful pure states is to be restricted to those representing coherent phenomena. (auth)

20312 GROUP PROPERTIES OF WAVE EQUATIONS FOR ZERO MASS PARTICLES. Ibragimov, N. Kh. (Inst. of Hydrodynamics, Novosibirsk, USSR). Dokl. Akad. Nauk SSSR, 178: 566-8(Jan. 21, 1968). (In Russian).

Conformally invariant wave equations for zero-mass particles, determined previously, did not prove that the conformal group obtained is the broad group which accepts these equations. A solution was obtained for a problem which sought a much broader local Lie group of point conversion for uniform Dirac, Maxwell, and weak gravitational field equations. (R.V.J.)

20313 MASS AND CHARGE RENORMALIZATION CONSTANTS IN QUANTUM ELECTRODYNAMICS WITHOUT A BARE MASS. Fomin, P. I. (Inst. of Physics and Tech., Kiev). JETP Lett. (USSR) (Engl. Transl.), 6: 385-7(Dec. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 972-5(Dec. 1, 1967).

It is shown that the theory with renormalization constants in quantum electrodynamics is substantially altered if the bare mass is not introduced into the theory and the electron mass is defined as the purely dynamic effect. Then m turns out to be linearly dependent on the cutoff parameter Λ with a nonanalytic dependence on the coupling constant while the charge renormalization is finite and the well-known difficulty with the nullification of the charge is eliminated. This result is connected with a definite departure beyond the framework of ordinary perturbation theory, although perturbation theory is used as part of the proof. (J.F.P.)

20314 WEAK CORRESPONDENCE PRINCIPLE. Klauder, John R. (Bell Telephone Labs. Inc., Murray Hill, N. J.). J. Math. Phys. (N. Y.), 8: 2392-9(Dec. 1967).

The weak correspondence principle (WCP) for a scalar field states that the diagonal matrix elements $G(f,g) \equiv \langle f,g|\mathcal{G}|f,g\rangle$ of a quantum generator $\mathcal{G}$ necessarily have the form of the appropriate classical generator G in which f(x) and g(x) are interpreted as the classical momentum and field, respectively. For a field operator $\varphi(x)$ and its canonically conjugate momentum $\pi(x)$ the states in question are given by $|f,g\rangle \equiv \exp\{i \int [\varphi(x)f(x) - \pi(x)g(x)]\, dx\}\, |0\rangle$, where $|0\rangle$ denotes the vacuum. The validity of the WCP is estab-

lished for the six Euclidean generators (plus the Hamiltonian) of a Euclidean-invariant theory, and for the ten Poincaré generators of a Lorentz-invariant theory. Only general properties and certain operator domain conditions are essential to the argument. The WCP holds whether the representation of π and φ is irreducible or reducible; in the latter case, the WCP holds even if the vectors $|f,g)$ do not span the Hilbert space, or even if the generator $\mathcal{G}$ is not a function solely of π and φ. Thus, the WCP is an exceedingly general and completely representation-independent connection between a classical theory and its quantum generators which is especially useful in the formulation of nontrivial, Euclidean-invariant quantum field theories. (auth)

20315 INTERNAL DYNAMICS OF PARTICLELIKE SOLUTIONS TO NONLINEAR FIELD THEORIES. Rosen, Gerald (Drexel Inst. of Tech., Philadelphia). J. Math. Phys. (N. Y.), 8: 2400-6(Dec. 1967).

A Rayleigh–Ritz procedure is set up for determining the approximate classical and quantum internal motion of a singularity-free solution to a nonlinear field theory. The dynamical approximation procedure is applied to the particlelike solutions of a nonlinear model scalar field theory and to the particlelike solutions of a class of nonlinear model scalar–spinor theories. Dynamically stable, metastable, periodic, and unstable particlelike solutions all follow for certain ranges of the physical parameters from the classical theory, but only corresponding metastable and unstable associated quantum stationary states are obtained for the nonlinear model theories considered. The functional dependence of the decay constant for the metastable quantum stationary states is such that very long-lived, practically stable, states are admissible. Group-theoretic techniques for the systematic derivation of rigorous particlelike solutions are also described and illustrated with examples. (auth)

20316 DAUGHTER REGGE TRAJECTORY IN A FIELD THEORY MODEL. Swift, Arthur R. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. J. Math. Phys. (N. Y.), 8: 2420-33(Dec. 1967). (COO-881-105).

All contributions of ladder diagrams in a $\lambda\phi^3$ theory with unequal masses which are asymptotically of order $t^{-2}\ln^m t$ are summed to give a family of secondary Regge trajectories. The analysis is carried out with the Mellin transformed scattering amplitude. The daughter Regge trajectory predicted by Freedman and Wang is identified. For equal internal masses on the sides of the ladder, the daughter pole has the following properties: The trajectory function $\alpha(s)$ is constant when calculated to lowest order in the coupling constant; that is, the pole is fixed. The pole moves in higher order, but the trajectory function has no two-particle cut. The residue of the pole has no two-particle cut, and vanishes to all orders for equal external masses. The amplitude with unequal internal masses is considered in lowest order, and it is shown that three-particle scattering should continue to dominate the daughter trajectory function although there is a two-particle cut. The daughter pole moves towards the physical region less rapidly than the leading pole, and it develops a smaller imaginary part at the two-particle threshold. It is concluded that a detailed statement about the motion of the daughter pole requires an accurate treatment of three-particle scattering. As a by-product of this work an earlier error in a treatment of the mixing of Regge poles and cuts is corrected. (auth)

20317 QUANTUM ELECTRODYNAMICS AT HIGH ENERGY. Brown, Laurie M. (Northwestern Univ., Evanston, Ill.). pp 95-129 of Proceedings of the Liperi Summer School in Theoretical Physics, 1967. Helsinki, University of Helsinki, 1967.

The simplification of the algebra for the calculation of higher-order processes is discussed. The theory is formulated in terms of two-component helicity spinors describing fermions of nonzero mass. The main features of this previous description of electrons is given. The perturbation expansion of its S-matrix contains the Klein–Gordon double corner terms corresponding to the simultaneous interaction of two photons with the electron. It is shown that these terms can always be eliminated leaving a simpler expression. At high energies this expression can be expanded in powers of m/E where m and E are mass and energy. It is shown that the leading term of this expression approximately conserves fermion helicity along the Feynman line, and this fact leads to further simplification. The calculation of high-energy limits is illustrated by several examples. (J.F.P.)

20318 GAUGE PROBLEM IN QUANTUM FIELD THEORY. II. DIFFICULTIES OF COMBINING EINSTEIN EQUATIONS AND WIGHTMAN THEORY. Strocchi, F. (Istituto Nazionale di Fisica Nucleare, Pisa, Italy. Scuola Normale Superiore, Pisa, Italy). Phys. Rev., 166: 1302-7(Feb. 25, 1968).

The results of a previous paper on the gauge problem in quantum electrodynamics are generalized to the gravitational case. In particular, the difficulties connected with the quantization of the gravitational field are analyzed in the framework of axiomatic field theory. For convenience, the simple case of weak gravitational field in vacuo is discussed. Even in this simple case, inconsistencies arise if one wants to combine the Einstein equations and quantum field theory. Under the assumptions: (1) existence of the vacuum, invariant under the Poincaré group such that the fields have tensor transformation properties, and (3) analyticity of the two-point function in this forward tube, it is proved that the Einstein equations for the gravitational potential have no solution apart from the trivial one $R_{\mu\nu\rho\sigma} = 0$. The result is obtained without assuming either local commutativity or the spectral condition or a positive metric in the Hilbert space. Thus the difficulties which arise in the quantization of the gravitational field have very little to do with the Hilbert-Lorentz condition, indefinite metric, etc.; rather, they are strongly connected with the definition of the Riemann tensor in terms of the gravitational potential. As a corollary of the above result, the representations of the Poincaré group for massless spin-2 particles in quantum field theory are shown to be essentially different from the corresponding ones of the classical case. (auth)

20319 METHOD OF HYPERQUANTIZATION. I. Takahashi, Yasushi (Dublin Inst. for Advanced Studies). Phys. Rev., 166: 1645-50(Feb. 25, 1968).

A hyperquantization method is reformulated. The energy-momentum and the charge operators are defined in this scheme. It is proved that the close connection between spin and statistics follows from the unitarity of the S matrix. A generalization of the method to fields with infinitely many components is suggested. (auth)

20320 EXISTENCE OF PRODUCTION AMPLITUDES FOR A NEUTRAL SCALAR FIELD WITHOUT PAIRING SYMMETRY. Cheung, Franklin F. K. (State Univ. of New York, Stony Brook). Phys. Rev., 166: 1828-32(Feb. 25, 1968).

A pole-pole contribution alone to the double density function in a neutral scalar field without pairing symmetry is shown to be inconsistent with the unitarity condition, so that the absence of production implies the absence of scattering, even though the pole-pole term gives rise to a Landau curve symmetric in s and t. (auth)

20321 APPROACH TO EQUAL-TIME COMMUTATORS IN QUANTUM FIELD THEORY. Brandt, Richard A. (Univ. of Maryland, College Park). Phys. Rev., 166: 1795-1821(Feb. 25, 1968).

Equal-time current commutators $[J(x),J'(x')]$ should be calculated as suitable equal-time limits of ordinary current commutators. Since this calculation is usually ambiguous or impractical, it is proposed instead to define them as limits of $[J(x;\xi),J'(x';\xi')]$ for $\xi,\xi' \to 0$, where $J(x;\xi)$ is a suitable nonlocal expression in the fields which converges to $J(x)$ for $\xi \to 0$. This alternative should be more reliable than the usual ones, such as taking equal-time limits inside of spectral representations or taking limits of time-ordered products from positive and negative time differences. The former procedure is invalid when the spectral function is nonintegrable, and the latter when equal-time δ functions are present. An analysis of two-point functions is presented which illustrates the above effects. In this connection, it is shown that the commutator $\langle 0|[j_k,j_4]|0\rangle$ in electrodynamics has a $\partial_k\Delta\delta(x-x')$ term in addition to the usual $\partial_k\delta(x-x')$ term. Our definition is shown to give correct results in a number of soluble models. It is then used to calculate commutators for electrodynamics in all orders of perturbation theory. The main new result is that, contrary to previous assertions, the commutator $[j_k(x),j_4(x')]$ is a q-number—essentially $e^4{:}A_2{:}\,\partial_k\delta(x-x')$ in the Gupta-Bleuler gauge. This result, together with a similar one for $[j_k(x),A_l(x')]$, is shown to be consistent with gage invariance and to be suitable for use in equal-time commutators which arise in reduction formulas. Finally, reduction formulas are used to explicitly establish the correctness of our results in fourth order. (auth)

20322 FURRY'S THEOREM AND INTERFERENCE OF ELECTRODYNAMIC AMPLITUDES. Henry, G. Reading (Stanford Univ., Calif.). Phys. Rev., 166: 1553-7(Feb. 25, 1968).

Furry's theorem is applied to electrodynamic interference terms where lepton polarizations are observed. Furry's theorem is also used to relate an arbitrary amplitude to the new amplitude obtained by charge-conjugating a single lepton line. (auth)

20323 PHENOMENOLOGICAL LAGRANGIAN FOR FIELD ALGEBRA, HARD PIONS, AND RADIATIVE CORRECTIONS. Lee, Benjamin W.; Nieh, H. T. (State Univ. of New York, Stony Brook). Contract 31-6016B. Phys. Rev., 166: 1507-15 (Feb. 25, 1968).

The phenomenological Lagrangian approach to the current-field

algebra, and its advantages and defects, are discussed. The computational rules are stated, and justification is offered. Based on phenomenological field-algebra Lagrangian, the electromagnetic effects on the pion mass (for finite pion mass), the ρ-meson mass, and the pion β decay are considered. (auth)

20324 GAUGE TRANSFORMATIONS IN THE S-MATRIX THEORY. Bialynicki-Birula, I. (Univ. of Rochester, N. Y.). Phys. Rev., 166: 1505-6(Feb. 25, 1968).

The gauge dependence of propagators in the S-matrix formulation of quantum electrodynamics is discussed. Gauge transformations are introduced as the transformations of photon wave functions. They form a very restricted class as compared to gauge transformations in the field-theoretic formulation. It is argued that one special choice of gauge is particularly appealing in the S-matrix formulation. The lowest-order radiative corrections to the electron propagator computed in this gauge coincide with the recent result obtained by Schwinger. (auth)

20325 PROPER-TIME FORMULATION OF QUANTUM MECHANICS. Cooke, James H. (Univ. of Manitoba, Winnipeg). Phys. Rev., 166: 1293-8(Feb. 25, 1968).

A quantum theory of relativistic scalar particles is developed in which the proper time τ is central. The unitarity and conservation laws which the theory exhibits with respect to τ are given acceptable physical interpretations. The problem of potential scattering of wave packets yields a result in agreement with Pauli-Weisskopf theory, except for the absence of vacuum processes. There is evidence that a finite theory of interacting particles is possible in the proper-time framework. (auth)

20326 LOW-ENERGY THEOREM FOR GRAVITON SCATTERING. Gross, David J. (Harvard Univ., Cambridge, Mass.); Jackiw, Roman. Phys. Rev., 166: 1287-92(Feb. 25, 1968).

A low-energy theorem for the scattering of gravitons from spin-0 particles is derived. The dispersion-theoretic method, recently utilized by Abarbanel and Goldberger to derive low-energy theorems for the Compton scattering of photons, is used to write unsubtracted dispersion relations for physical helicity amplitudes. The scattering amplitude at fixed angle is shown to be given by the Born approximation up to fourth-order terms in the graviton energy. (auth)

20327 ALGEBRAIC SOLUTION IN THE V$-\theta$ SECTOR OF THE LEE MODEL. Bolsterli, M. (Univ. of Minnesota, Minneapolis. Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 166: 1760-7 (Feb. 25, 1968). LA-DC-8932.

A set of equations for the V$-\theta$ sector of the Lee model is solved by purely algebraic techniques. It is shown that the integral equations involved are like those that arise in scattering by a separable potential, in that their solution requires no integral-equation techniques. (auth)

Gravitation and General Relativity

Refer also to abstracts 19703, 20074, 20100, 20312, and 20318.

20328 (LPTHE-TH-237) COLLECTIVE MOTIONS OF THE RELATIVISTIC GRAVITATIONAL GAS. Droz-Vincent, Ph. (Paris Univ. (France). Institut Henri Poincare); Hakim, Remi (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Dec. 1967. 26p. Dep.

The relativistic gravitational gas is studied with the help of the linearized Einstein equations coupled to the one-particle Liouville equation. As a consequence, a kinetic equation is derived for the collective motions of a small perturbation of the gas. This equation is a linear integro-differential equation of the same kind as the Vlasov equation. (auth)

20329 REVISED THEORY OF GENERAL RELATIVITY AND QUANTIZATION OF THE GRAVITATIONAL FIELD. I. Rayski, J. (Jagellonian Univ., Krakow). Acta Phys. Pol., 33: 119-28 (Jan. 1968).

The theory of general relativity, if applied to the case of isolated gravitational fields, bears no resemblance to other field theories because a nonvanishing energy of limited gravitational wave packets cannot be defined, or such packets do not exist. This and other peculiarities necessitate a revision of the foundations of general relativity. The process of time measurement is analyzed. The principle of general covariance is criticized and revised. A distinguished class of normal coordinate systems, deserving the name of "inertial with respect to a set of (compatible) hypersurfaces of measurements," is introduced, and Hilbert's variational principle is modified by taking account of the coordinate conditions. The modified theory also satisfies the principles of equivalence, general relativity, and of general covariance (though in a weaker sense). The modified theory admits a more general class of solutions, may be easily put into a canonical form, and quantized. In the quantized version there appears a new sort of complementarity: if the hypersurface of measurement is determinate, the number of scalar and longitudinal gravitons is completely indeterminate and vice versa. (auth)

20330 PROBLEM OF QUANTIZATION OF SPACE–TIMES. Meessen, A. (Univ., Louvain, Belg.). Ann. Soc. Sci. Brux. Ser. 1, 81: 254-71(Dec. 31, 1967). (In French).

Extrapolating the known laws of electrodynamics and gravitation to arbitrarily small distances, one encounters difficulties, which suggest the necessity of introducing some "fundamental length." The same arguments lead us, however, to expect its magnitude to be much smaller than the values currently admitted, of 10^{-14} or 10^{-23} cm. On the other hand, it is possible to generalize the laws of mechanics for all momenta and energies, with the assumption of a space-time lattice, without contradicting the principle of relativity. Replacing the differential equation for the probability amplitude by a difference equation, one finds a modified dispersion law, from which it can be concluded that the "fundamental length" is probably of the order of 10^{-90}–10^{-95} cm, but certainly smaller than 10^{-80} cm. (auth)

20331 SOME ASPECTS OF THE INTERACTION OF A CLASSICAL GRAVITATIONAL FIELD WITH A QUANTIZED MATTER FIELD. Halpern, L. (Univ. of Stockholm). Ark. Fys., 34: 539-60(1967).

The modifications of a classical gravitational field produced by the interaction with a virtual quantized matter field were investigated for the static case with the help of perturbation theory and covariant Green's functions. The induced energy-momentum density is evaluated explicitly in the first order and expressed in terms of the gravitational field. It was shown that this induced energy-momentum density becomes of equal magnitude to that of the inducing gravitational field at a radial distance comparable to the Compton wavelength of the central body which produces the gravitational field. The removal of the divergent terms from the Lagrangian was performed; their features are discussed and critically compared with the results of previous investigations. The modified gravitational field equations and the equation R = 0, which serves as a subsidiary condition, are discussed. Physical and formal aspects of the results are contemplated. (auth) (Sweden)

20332 SOME NEW GENERAL RELATIVISTIC DUST METRICS POSSESSING ISOMETRIES. Farnsworth, David L. (Univ. of Pittsburgh). J. Math. Phys. (N. Y.), 8: 2315-17(Dec. 1967).

In a four-dimensional Lorentzian manifold in which Einstein's gravitational field equations hold with the field produced by pressure free dust, a significant set of new solutions is found. Assuming that the manifold possesses a four parametric group of isometries of type 5 in Bianchi's classification, which act on a three-dimensional negative definite subspace, all metrics are found. The solutions are unusual in that the geodesics which the particles follow are not orthogonal to the three-dimensional negative-definite subspace so that the space will not appear homogeneous to these observers. The isotropic expansion is nonzero for almost all these solutions. (auth)

20333 GRAVITATIONAL RADIATION IN THE LIMIT OF HIGH FREQUENCY. II. NONLINEAR TERMS AND THE EFFECTIVE STRESS TENSOR. Isaacson, Richard A. (Univ. of Maryland, College Park). Phys. Rev., 166: 1272-80(Feb. 25, 1968).

The high-frequency expansion of a vacuum gravitational field in powers of its small wavelength is continued. The previously discussed linearization of the field equations is extended to consider the lowest-order nonlinearities. These are shown to provide a natural, gauge-invariant, averaged stress tensor for the effective energy localized in the high-frequency gravitational waves. Under the assumption of the WKB form for the field, this stress tensor is found to have the same algebraic structure as that for an electromagnetic null field. A Poynting vector is used to investigate the flow of energy and momentum by gravitational waves, and it is seen that high-frequency waves propagate along null hypersurfaces and are not back-scattered by the lowest-order nonlinearities. Expressions for the total energy and momentum carried by the field to flat null infinity are given in terms of coordinate-independent hypersurface integrals valid within regions of high field strength. The formalism is applied to the case of spherical gravitational waves where a news function is obtained and where the source is found to lose exactly the energy and momentum contained in the radiation field. Second-order terms in the metric are found to be finite and free of divergences of the (lnr)/r variety. (auth)

20334 GRAVITATIONAL RADIATION IN THE LIMIT OF HIGH FREQUENCY. I. THE LINEAR APPROXIMATION AND

GEOMETRICAL OPTICS. Isaacson, Richard A. (Univ. of Maryland, College Park). Phys. Rev., 166: 1263-71(Feb. 25, 1968).

A formalism is developed for obtaining approximate gravitational wave solutions to the vacuum Einstein equations of general relativity in situations where the gravitational fields of interest are quite strong. To accomplish this the wave is assumed to be of high frequency and the vacuum field equations are expanded in powers of the correspondingly small wavelength, getting an approximation scheme valid for all orders of 1/r, for arbitrary velocities up to that of light, and for all intensities of the gravitational field. To lowest order in the wavelength, a gauge-invariant linearized equation is obtained for gravitational waves which is just a covariant generalization of that for massless spin-2 fields in a flat background space. This wave equation is solved in the WKB approximation to show that gravitational waves travel on null geodesics of the curved background geometry with their amplitude, frequency, and polarization modified by the curvature of space-time in exact analogy to light waves. (auth)

20335 SOME SOLUTIONS OF EINSTEIN'S EQUATIONS IN GENERAL RELATIVITY. Marek, J. J. J. (University Coll. of Wales, Aberystwyth). Proc. Cambridge Phil. Soc., 64: 167-70(Jan. 1968).

A new class of axi-symmetric stationary solutions of Einstein's empty-space field equations is obtained. Nonexistence of solutions of certain other classes is proved. (auth)

Scattering Theory

Refer also to abstracts 20159, 20170, and 20179.

20336 (INP-555/PH, pp 73-89) PHASE FUNCTION METHOD IN POTENTIAL SCATTERING THEORY. Babikov, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics).

The phase function method is given as an approach to quantum mechanical problems. This method can be used in calculations of parameters and energies of bound states. Phase and amplitude functions, the phase equation, low-energy scattering, approximate methods, and bound states are covered. (J.F.P.)

20337 (INP-555/PH, pp 171-81) REMARKS ON MACROSCOPIC CAUSALITY. Rzewuski, J. (Wroclaw Univ. (Poland). Inst. of Theoretical Physics).

An attempt is made to formulate the principle of macroscopic or asymptotic causality in the framework of a functional formulation of the S-matrix theory. For this purpose the basic assumptions of a local theory are briefly reviewed in terms of functionals. The topics covered are the postulates of local field theory, equivalence classes, and macroscopic causality. (J.F.P.)

20338 (INP-555/PH, pp 213-22) KINEMATICAL SINGULARITIES OF THE SCATTERING AMPLITUDES. Kotanski, A. (Jagellonian Univ., Krakow (Poland). Inst. of Physics).

Some investigations of the kinematical singularities of helicity amplitudes are reviewed. Also the amplitudes in which the spins are projected on the beam direction are discussed. It is argued that they have simpler kinematical singularities than the helicity amplitudes. (J.F.P.)

20339 (JINR-E2-3728) A LOWER BOUND OF THE ELASTIC SCATTERING AMPLITUDE AT FIXED MOMENTUM TRANSFER. Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 5p. Dep.

A lower bound of the cross section decrease is obtained in the physical region $t < 0$ on the basis of the analytic properties of the scattering amplitude. (auth)

20340 (JINR-P2-3692) ORBITIROVANIE I REZONANSNYE SOSTOYANIYA. (Orbiting and Resonance States). Lukach, I.; Smorodinskii, Ya. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 23p. (In Russian). Dep.

The behavior of the characteristics of an elastic potential scattering process at energies of the order of the effective potential barrier is investigated in the framework of the quantum mechanics. This phenomenon is known in the classical scattering theory as orbiting (helicity scattering). It is found out, that at the energies of incident particles equal to the height of an effective potential barrier, there appears a resonance corresponding to the quasi-stationary state. The effective potential barrier height is an angular momentum function of incident particles and thus one obtains the resonance trajectory determining the family of resonance energies for different angular momenta. (auth)

20341 (JINR-P2-3694) OB ODNOZNACHNOSTI RESHENIYA URAVNENII DLYA "PARTSIAL'NYKH" AMPLITUD V RELYATIVISTSKOI ZADACHE TREKH CHASTITS. (On the Uniqueness of the Solution of the Equations for the "Partial" Amplitudes in the Relativistic Three-Particle Problem). Stoyanov, D. Ts. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 8p. (In Russian). Dep.

The uniqueness of the solution of the equations for the partial amplitudes in the three-particle problem was proved. The equations of these amplitudes and the amplitudes themselves were previously derived for the relativistic case by Stoyanov and Shelest (Physics Letters, 13, No. 3 (1964)). (auth)

20342 REGGE CUTS AND ABSORPTIVE CORRECTIONS. Squires, E. J. (Univ. of Durham, Eng.). Phys. Lett., 26B: 461-3(Mar. 4, 1968).

It is suggested that Regge cuts dominate high energy elastic scattering. The mechanism for their creation then suggests that their contribution to inelastic amplitudes will be small, and will be given by a formula which resembles that obtained by applying absorptive corrections to the Regge pole model. (auth)

20343 UNITARY REPRESENTATIONS OF THE LORENTZ GROUP AND FUNCTIONS WITH SPIN. Liberman, M. A.; Smorodinskii, Ya. A.; Sheftel, M. B. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 202-14(1968). (In Russian).

Irreducible unitary representations of the Lorentz group, realized on the space of functions defined on the direct product of two spaces—the hyperboloid (with the infinite dimensional representation) and the sphere (with the finite dimensional spin representation) were constructed. These functions are the basis for the integral representation of scattering amplitudes. They form also a complete set of functions to decompose an arbitrary solution of relativistic field equations for fields with a definite spin. (auth)

20344 RESULTS ON THE ANALYTICITY OF MANY-BODY SCATTERING AMPLITUDES IN PERTURBATION THEORY. Federbush, Paul (Univ. of Michigan, Ann Arbor). J. Math. Phys. (N. Y.), 8: 2415-19(Dec. 1967).

The problem of analytic continuation of the many-body scattering amplitude associated with a perturbation-theory diagram under the rotation of the final momenta from real to complex momenta, $k \to (1 + i\theta)k$, is studied. It is shown that the contour of integration over internal momenta can be distorted avoiding singularities of the integrand, as θ varies for small enough θ. If the diagram is connected enough, the potentials are Yukawa-type, Re $E > 0$, and Im $E < 0$. The rotation angle can be picked independently of Im E. (auth)

20345 INVARIANT IMBEDDING AS A GENERALIZATION OF THE RESOLVENT EQUATION. Mockel, Andre (Univ. of Florida, Gainesville). J. Math. Phys. (N. Y.), 8: 2318-21 (Dec. 1967).

Invariant imbedding equations for the Green's function of a general linear operator are shown to derive from a generalization of the resolvent equation of the theory of operators. Two applications are given: the neutron, or photon, transport in an arbitrary finite body, and the quantum-mechanical theory of collision. In the last case, a nonlinear differential equation for the amplitude of transition $T^{\beta\alpha}$ from a channel α to a channel β with conservation of the total energy is derived from the general equation. (auth)

20346 CAUSALITY AND THE S MATRIX. Ranada, Antonio F. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). J. Math. Phys. (N. Y.), 8: 2321-6(Dec. 1967).

A formalism is presented in order to impose causality conditions for finite-range interactions which do not require the existence of wave packets with a sharp front. The absence of bound states and particle production is assumed. Two different causality conditions—referred to as strong and weak conditions—are studied. It is shown that in general the convolution kernel that connects the ingoing with the outgoing wave is not zero in the past. Some analytic properties of the S matrix are deduced. (auth)

20347 ON THE DETERMINATION OF THE MANY-CHANNEL POTENTIAL MATRIX AND S MATRIX FROM A SINGLE FUNCTION. Cox, Joseph R. (Florida Atlantic Univ., Boca Raton). J. Math. Phys. (N. Y.), 8: 2327-31(Dec. 1967).

It is shown that, for a certain model of many-channel potential scattering, there exists, under rather general conditions, a single function from which both the potential matrix V and the corresponding S matrix can be constructed. This function is the Fredholm determinant of the Lippmann–Schwinger equation for the physical wave function of a system having a potential matrix which is identical with V in the interval from the origin out to a distance r, but which vanishes identically beyond this distance. A one-channel and a two-channel example are discussed. (auth)

20348 GENERALIZATION OF THE DETERMINANT METHOD TO CONTINUOUS CHANNELS. Newton, Roger G. (Indiana Univ., Bloomington). J. Math. Phys. (N. Y.), 8: 2347-50(Dec. 1967).

The procedure by which all elements of the S matrix in multichannel scattering problems are expressed in terms of the Fredholm determinant of the Lippmann–Schwinger equation, is generalized to the case of "continuous channels." This is a preliminary step toward its generalization to three (or more)-particle problems, in which the possibility of "ionizing" an initial bound state always introduces such a continuum. It is found that, whereas in the case of discrete channels the necessary functions can be obtained from the Fredholm determinant either by analytic continuation in the total energy, or by a "substitution rule," for continuous channels only the latter procedure works, and it is not equivalent to an analytic continuation. (auth)

20349 PROPERTIES OF THE WAVEFUNCTION FOR SINGULAR POTENTIALS. Spector, Richard M. (Wayne State Univ., Detroit). J. Math. Phys. (N. Y.), 8: 2357-65(Dec. 1967).

For potentials more singular than the inverse square at the origin and with complex strength, the nature of the solutions to the Schroedinger equation is investigated. The difficulties occurring with attractive real potentials in the three-dimensional equation are discussed, and it is shown that no solutions exist in a domain including the origin. For complex or repulsive singular potentials with radial form varying as the inverse fourth or sixth power, a relatively simple series solution exists. This is also true for the singular Yukawa with inverse fourth power. These series are shown to be asymptotic by means of general theorems from the theory of ordinary differential equations. Other inverse powers have much more complicated solutions. In the Dirac case, all inverse powers and singular Yukawa forms have asymptotic series solutions, and the series is given explicitly for the singular powers. A form of the S-wave scattering length for the singular inverse fourth-power Yukawa $V = g^2 e^{-i\Delta} e^{-\mu r}/r^4$ is derived which is valid for small values of μg. (auth)

20350 TIME-DEPENDENT VARIATIONAL PRINCIPLE. Su, Der-ruenn (National Taiwan Univ., Taipei). Chin. J. Phys. (Taiwan), 5: 100-6(Oct. 1967).

Variational principles for the quantum theory of scattering are given. Four variational principles give the matrix elements of transition operator and two variational principles give the matrix elements of reaction operator. All the forms of the variational principles are similar to the Schwinger variational principle for the scattering amplitude in the stationary collision theory. (auth)

20351 REGGE ASYMPTOTIC BEHAVIOR FOR COLLISIONS OF PARTICLES WITH SPIN. Abarbanel, Henry (Princeton Univ., N. J.). pp 1-40 of Proceedings of the Liperi Summer School in Theoretical Physics, 1967. Helsinki, University of Helsinki, 1967.

The behavior of the S-matrix elements for large values of their arguments is studied using Regge pole phenomenology. It is assumed that Regge asymptotic behavior gives an accurate guide to the correct asymptotic behavior of scattering amplitudes. The description of scattering processes involving spinning particles following the development of Jacob and Wick, the idea of Regge asymptotic behavior for transition amplitudes, complex angular momentum, and some applications of these ideas and experimental evidence for their validity are covered. (J.F.P.)

20352 PHYSICS BEHIND ANALYTICITY IN MOMENTUM TRANSFER AND HIGH ENERGY BOUNDS. Roskies, Ralph (Yale Univ., New Haven). pp 187-224 of Proceedings of the Liperi Summer School in Theoretical Physics, 1967. Helsinki, University of Helsinki, 1967.

Analyticity in momentum transfer t for fixed energy is considered. The ideas of Omnes are presented, and previous work on t analyticity in field theory is reviewed. A formulation of field theory is adopted in which particles are represented by interpolating fields built out of finite products of some basic fields at different space–time points. A very physical approach to t analyticity and to high-energy bounds is presented, and results for bound-state scattering are given. (J.F.P.)

20353 CONSPIRACY AND EVASION: PROPERTY OF REGGE POLES. Leader, Elliot (Cambridge Univ., Eng.). Phys. Rev., 166: 1599-1621(Feb. 25, 1968).

It is shown that if standard methods are used to apply the Regge-pole theory to relativistic problems in which the external particles have nonzero spin, then there exist constraint equations which enforce relationships between the residue and trajectory functions of the participating poles in the region $t \sim 0$. The constraint equations follow directly from general quantum-mechanical principles and it is therefore essential to satisfy them. Moreover, the number of constraint equations increases roughly as the fourth power of the spin of the external particles. The structure of the constraint equations also differs radically according to whether the t-channel process has equal-mass particles in both the initial and the final state or unequal-mass particles in both the initial and the final state. A separate treatment of the various situations is given. Several examples are worked out in detail: $\pi N \to \pi N$, $\pi N^* \to \pi N^*$, $\pi\rho \to \pi\rho$, $NN \to NN$, and $\rho\rho \to \rho\rho$. The discussion of the general case in which the external particles have arbitrary spins requires a slight extension of previously given methods for the Reggeization of processes with spin. A very simple, and completely general scheme for the Reggeization, and for the classification of the Regge poles involved, is given. Finally, a discussion is given of the fundamental underlying group-theoretical origin of the constraint equations, and it is suggested that the necessity to satisfy them artificially represents a weakness in our present methods of applying Regge-pole theory to relativistic processes. (auth)

20354 DYNAMICS BASED ON RISING REGGE TRAJECTORIES. Mandelstam, Stanley (Univ. of California, Berkeley). Phys. Rev., 166: 1539-52(Feb. 25, 1968).

An outline is given of a dynamical scheme based on rising Regge trajectories. The fundamental approximation is that the scattering amplitude can be approximated by the contribution of a finite number of Regge poles. An additional simplifying assumption is that the Regge trajectories are straight lines or, equivalently, that the scattering amplitude is dominated by narrow resonances. Unitarity is introduced by means of the Cheng-Sharp equations, but, in the narrow-resonance approximation, a very trivial solution of these equations is adopted. Crossing is introduced by means of the generalized superconvergence relations due to Igi and to Horn and Schmid. Levinson's theorem is not used; the bootstrap condition is the absence of Kronecker-δ singularities in the J plane. It is hoped that this scheme avoids some of the disadvantages of conventional schemes. In the narrow-resonance approximation one has to solve numerical equations, not integral equations. The scheme is applied to the pseudoscalar, vector, and axial-vector nonets considered as bound states of the $N\bar{N}$ system. As only one channel is being examined, certain parameters have to be introduced from experiment, but reasonable values are obtained for the other parameters. (auth)

20355 DAUGHTER REGGE TRAJECTORIES IN THE VAN HOVE MODEL. Sugar, R. L. (Univ. of California, Santa Barbara); Sullivan, J. D. Phys. Rev., 166: 1515-20(Feb. 25, 1968). (SLAC-PUB-336).

The Van Hove model of Regge poles is generalized to include propagator self-energy insertions and used to study unequal-mass daughter trajectories. The first daughter trajectory is found to have negative slope at $t = 0$. (auth)

20356 CORRESPONDENCE BETWEEN UNSTABLE PARTICLES AND POLES IN S-MATRIX THEORY. Calucci, G.; Fonda, L.; Ghirardi, G. C. (Univ., Trieste, Italy). Phys. Rev., 166: 1719-23(Feb. 25, 1968).

The correspondence (unstable particle) $\to$ (pole of the S matrix) is discussed. In particular, it is explicitly shown that S matrices, satisfying all requirements of analyticity, unitarity, and threshold and asymptotic behavior in energy, can be constructed in such a way that a sharp isolated resonance is produced without an accompanying pole in the unphysical sheet. As a matter of fact, in two of the examples, no singularities, except kinematical and dynamical branch lines, are found in any sheet of the energy Riemann surface. (auth)

20357 NEW APPROACH TO RELATIVISTIC OFF-SHELL DYNAMICS. Remler, E. A. (Univ. of California, Livermore). Phys. Rev., 166: 1710-18(Feb. 25, 1968).

A framework for doing relativistic off-shell dynamics is developed from basic principles. The resultant equations can be considered as generalizations of the Low equation. They are completely covariant and connected. The relativistic two- and three-body problems are given as examples of the general procedure. (auth)

20358 COMMENTS ON LEVINSON'S THEOREM. Coulter, Philip W.; Garg, Ramesh C.; Shaw, Gordon (Univ. of California, Irvine). Phys. Rev., 166: 1708-10(Feb. 25, 1968).

An example of a simple one-pole, two-channel model (with angular momentum >0) is presented in which the one-channel ND^{-1} equations with inelastic unitarity are not equivalent to the multichannel ND^{-1} equations for large nondiagonal forces. Even though the potential terms are smoothly varying, it is found that large changes in the real part of the phase shift can occur at energies that are extremely high in relation to the masses and coupling constants in the problem. The low-energy phase shifts can be found by solving the corresponding one-channel problem with inelastic unitarity. A discussion of the practical application of Levinson's theorem is presented. (auth)

20359 ANALYTICITY IN MOMENTUM TRANSFER WITHOUT STRICT LOCALITY. MacDowell, S. W.; Roskies, R. (Yale Univ., New Haven). Phys. Rev., 166: 1703-7(Feb. 25, 1968). (YALE-2726-506).

Following the method of a previous paper on the application of the cluster properties in field theory to the derivation of bounds on the partial waves for the elastic scattering of two particles, it is shown that for particles described by not-strictly-local fields, the scattering amplitude is analytic in momentum transfer in an ellipse that is smaller than the Lehmann ellipse but has the same energy dependence at high energies. No attempt was made to get the best possible domain of analyticity. This result also holds in a scattering theory formulated in terms of local observables. (auth)

20360 CLUSTER PROPERTY AND BOUNDS ON THE SCATTERING AMPLITUDE. MacDowell, S. W.; Roskies, R.; Schroer, B. (Yale Univ., New Haven). Phys. Rev., 166: 1691-1702(Feb. 25, 1968).

The cluster property of Wightman functions is used to derive a bound on the partial-wave amplitudes for the elastic scattering of two particles described by not-strictly local fields. This leads to the Greenberg–Low bound on the total cross section independently of analyticity in momentum transfer. The results are also shown to hold within the framework of local observables. (auth)

Particle Accelerators

Refer also to abstracts 19333, 20072, 20073, 20087, 20153, 20170, 20497, and 20975.

20361 (AERE-R-5591) THE GAMMA IRRADIATION FACILITY ON THE HARWELL LINAC. Baker, C. A.; Thomas, P. P.; Williams, D. R. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1967. 17p. Dep. CFSTI. UK 4s. 0d.

Gamma irradiation using photons of up to 45 MeV is a routine operation. The installation at the Harwell Linac, which has been built for this purpose is described together with details of operation and performance. (auth)

20362 (BNL-12138) THEORY AND DESIGN OF BEAM TRANSPORT SYSTEMS. Norman, B. A.; Moore, W. H. (Brookhaven National Lab., Upton, N. Y.). Sept. 1, 1967. 233p. Dep. CFSTI.

A detailed analysis is presented in an effort to provide reasonably accurate input data for convergent beam programs. An investigation of the problem of transporting an emittance ellipse from one accelerator into an acceptance ellipse by a following accelerator is described. Beam transport systems considered are limited to those through which singly-charged beam particles pass only once and are not accelerated longitudinally. Linear optics is applied to all problems. Quadrupoles are replaced by thin lenses and their effective lengths added to the drift space. Nondispersive systems and dispersive systems with homogeneous field sector magnets are examined. Beam transport programs are described which calculate the optical parameters after convergence in terms of matrix elements and also plot the phase ellipses. Also, transverse space-charge effects are examined. (W.H.K.)

20363 (BNL-12231) TRANSIENT BEAM LOADING IN STANDING WAVE LINACS. Lee, M. J. (Brookhaven National Lab., Upton, N. Y.). Feb. 5, 1968. 14p. Dep. CFSTI.

The amplitude of the beam-induced field in standing wave linacs, taking into account the changes in the beam velocity and cavity cell length, is calculated. (W.H.K.)

20364 (CEA-R-3383) TABLE DES ENERGIES DES PARTICULES CHARGEES EN FONCTION DE LA RIGIDITE MAGNETIQUE (Bρ) POUR p,d,t, ^{3}H, α PARTICLES (10^5 < Bρ < 1.2 × 10^6 G cm). (Table of Charged Particle Energies Versus Magnetic Field Strength × Orbit Radius (Bρ) for p,d,t, ^{3}He, α Particles (10^5 < Bρ < 1.2 × 10^6 G cm)). Bianchi, Louis (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec, 1967. 44p. (In French). Dep.

A table of charged particle energies versus magnetic field strength × orbit radius (Bρ) is presented. Particles included are p,d,t, $^3He^{++}$, $^4He^{++}$. Values of Bρ range from 1 × 10^5 to 1.2 × 10^6 G cm by steps of 500 G cm. (auth)

20365 (CEAL-1038) SEMIANNUAL REPORT [ON ELECTRON ACCELERATOR], JANUARY 1–JUNE 30, 1967. (Cambridge Electron Accelerator, Mass.). Dec. 15, 1967. Contract AT(30-1)-2076. 37p. Dep. CFSTI.

Accelerator operation, principal improvements made in the accelerator and in the associated facilities, delivery and assembly of the new 100-MeV linac, the nature of each of the 34 experiments in progress or in preparation, safety, and the steady progress on Project Bypass are reported. Also, the planning of the Sixth International Conference on High Energy Accelerators is discussed. (W.H.K.)

20366 (DESY-68/3) DIE STRAHLFUEHRUNGSSYSTEME FUER DEN 300 MeV-LINEARBESCHLEUNIGER. (The Beam Transport System for the 300 MeV Linear Accelerator). Wiedemann, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jan. 1968. 57p. (In German). Dep.

The optics and geometry of the beam transport system between the 300 MeV–Linac and the synchrotron are described, including the beam observation and correction system. In addition, the special systems for positron focussing in the linac are discussed. (auth)

20367 (DESY-68/5) STRONG FOCUSSING IN LINEAR ACCELERATORS. Wiedemann, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jan. 1968. 18p. Dep.

To focus large emittance positron beams in linear accelerators, both a solenoid field and a FODO channel consisting of a set of quadrupoles with alternating gradients may be used. A thin lens theory for a FODO channel in accelerated particle systems was given by R. H. Helm. The transformation matrices for such a FODO channel consisting of quadrupoles of finite magnetic length are derived. It was found that the thin lens theory gives too optimistic results with respect to the transmitted beam emittance. The diviations from the thin lens theory are shown in diagrams for various parameters. (auth)

20368 (HEPL-297(Rev.A)) STUDY OF BEAM BLOW-UP IN ELECTRON LINACS. Wilson, P. B. (Stanford Univ., Calif. High-Energy Physics Lab.). June 1963. 42p.

The phenomenon of pulse shortening or beam blowup in linear electron accelerators is examined. The assumption is made that the effect can be explained as a backward-wave oscillation in which the beam interacts with the TM_{11}-like mode of propagation in the accelerator structure. As an introduction to the principal calculation, standard backward-wave oscillator (BWO) theory is first examined. A correction is made for a relativistic beam, and the result is then applied to the Stanford Mark III accelerator. It is shown that, because of the relativistic factor for longitudinal bunching, an accelerator section cannot oscillate in the usual TM_{01}-like mode when rf power is on. However, if the gun and injector are turned on with no rf on, a starting current in this mode of about 1 ma is calculated for oscillation in the initial capture section. The existence of this predicted oscillation was experimentally verified on the Mark III accelerator. The interaction of the beam with the TM_{11}-like transverse deflection mode is next examined. An attempt is made to present a clear physical picture of the oscillation mechanism in which transverse momentum is imparted to the beam in the front part of the structure, and energy is transferred from the dc beam to the rf field in the rear part of the structure. The mathematical details of the calculation of the starting current for oscillation are worked out for the case of no rf input (passive section). A correction is then applied to take into account loss on the structure, and an approximate correction is made for the case of an active section. A comparison is made between the calculated starting current, using the theory developed here, and the experimentally observed starting current for the Hughes Aircraft Co., Research Linac. The agreement is very good. On the basis of the theory, accelerator design methods are straightforward for eliminating the beam blowup effect. The variation of on-set time for beam blowup as a function of starting current is examined briefly. A simple physical picture is presented which yields reasonable agreement with the observed data. (auth)

20369 (INS-J-106) NUMERICAL TABLES OF THE SOLID ANGLE AND R(X) OF A MAGNETIC ANALYZER SYSTEM FOR THE INS FM CYCLOTRON. Kokame, J.; Yagi, K. (Tokyo Univ. (Japan). Inst. for Nuclear Study). Dec. 21, 1967. 25p. Dep.

Tabulations for calibrating the solid angle of the magnetic spectrometer used at the INS FM cyclotron are presented. Also, data are presented comparing the radii of the beam trajectories in the main-beam magnet and the secondary-particle magnet. This is used to calibrate the magnetic analyzer system for absolute measurement of the energies of the product particles. (W.H.K.)

20370 (KN-67-655(R)) LONG-LIVED TARGETS. Jessen, P. L. (Kaman Nuclear, Colorado Springs, Colo.). [nd]. 14p. (CONF-670960-1). Dep. CFSTI.

From 3rd International Meeting on Accelerator Targets Designed for the Production of Neutrons, Liege, Belgium.

The development of high yield neutron generators using nonpumped or sealed ion accelerators is discussed. Relative neutron yields from copper, manganese, nickel, and titanium targets bombarded with mixed deuterium and tritium ions are presented. Also, the solubility of hydrogen in these targets is considered since it is an important factor in this method of neutron production. (W.H.K.)

20371 (NP-17274) VORSCHLAG ZUM BAU EINES 40 GeV PROTONENSYNCHROTRONS. (Proposal to Build a 40 GeV

Proton Synchrotron). (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). July 1967. 250p. (In German). Dep.

A proposal for the construction of a 40 BeV proton synchrotron is presented, which represents a technical and economic variant to other existing and planned accelerators. The proposed synchrotron would have a small magnet aperture, a linear accelerator, and an intermediate synchrotron as injector. The scientific foundations for the design of such an accelerator are given, and the basic conception is outlined. The intensity of the extracted beam is designed as 10^{12} protons/sec. The structure of the accelerator was described by a selection and calculation of parameters which characterize the particle orbit in the principal synchrotron. The building and the radioprotection features are described. A cost estimation is given and a tentative construction plan is presented. (J.S.R.)

20372 (ORNL-TM-2116) APPLICATION NOTES ON THE IMMEDIATE ANALYSIS COMPUTER DISPLAY SYSTEM FOR ORELA DATA ACQUISITION AND HANDLING. Reynolds, J. W. (Oak Ridge National Lab., Tenn.). Jan. 30, 1968. Contract W-7405-eng-26. 19p. Dep. CFSTI.

A possible equipment configuration for the immediate analysis of ORELA experimental data is described. Minimum software requirements are stated. Light pen interactions with a data set are shown on an existing system. Several examples of how the displays could be used in particular experiments are discussed briefly. (auth)

20373 (PPAD-637-D) TRANSVERSE AND LONGITUDINAL SPACE CHARGE EFFECTS IN A SYNCHROTRON. Prelec, K. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Feb. 2, 1968. Contract AT(30-1)-3217. 24p. Dep. CFSTI.

The synchrotron theory has been extended by including space charge electric field terms. Results show that in the case of a beam injected with modulated energy there will be in addition to a decrease in betatron frequencies also a beam spreading in radial direction and an increase in synchrotron frequency. Possible effects on particle loss during the injection and capture are discussed. (auth)

20374 (RHEL/R-155) NIMROD OPERATION AND DEVELOPMENT QUARTERLY REPORT, JULY 1-SEPTEMBER 30, 1967. Gray, D. E. (ed.) (Rutherford High Energy Lab., Chilton (England)). Oct. 1967. 27p. Dep. UK 4s. 0d.

The NIMROD beam was on for High Energy Physics Research for 67.86% of H.E.P. scheduled operating time. One experiment was completed, three continued through and one commenced this quarter. A target mechanism which facilitates rapid changing of internal targets inside the NIMROD vacuum vessel is described. Radiation surveys associated with the extracted proton beam are discussed. Construction of the second extracted proton beam and associated subsidiary beams continues. (auth)

20375 (RHEL/R-158) CONTROL OF THE R.F. IN A PROTON SYNCHROTRON WITH BEAM LOADING. Rees, G. H. (Rutherford High Energy Lab., Chilton (England)). Jan. 1968. 13p. Dep. UK 2s. 6d.

Control of the rf in a beam loaded proton synchrotron involves four coupled control loops. A computer program was written to evaluate the transfer functions of these interacting loops. (auth)

20376 (AD-661900) ACCELERATOR-BUNCHER OF ELECTRONS. Kosarev, E. L. Translated from Elektron. Bol'shikh Moshch., No. 4, 190-205(1965). 17p. (FTD-MT-66-159). CFSTI.

This article was previously abstracted from the original language and included in NSA as 20: 29859. (B.G.D.)

20377 (UCRL-Trans-1363) STARTING UP OF BETATRON B-3 WITH EXTERNAL INJECTION. Bikmatov, R. G.; Boriskin, A. G.; Glagolev, G. B.; Goriachev, S. B.; Kudelainen, V. I.; Meshkov, I. N.; Pecherskii, E. A.; Chirikov, B. V. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated for Univ. of California, Lawrence Radiation Lab., Berkeley from a Preprint. 42p. Dep. CFSTI. JCL $4.60 fs, $1.36 mf.

The theory of a betatron with electron spiral stacking is described. The question of the beam current limit is discussed from the point of view of intensive beam instabilities. The experiments on the external injection into the betatron with the injection energy 150 and 220 keV are described. The discussion of the results shows that beam current is limited by the parametric resonance of incoherent betatron oscillation. A short review of the known circular beam instabilities in the weak focusing accelerators is given. (auth)

20378 (UCRL-Trans-10214) PARTICLE OPTICAL CHARACTERISTICS OF AN ELECTROSTATIC DEFLECTOR IN A MAGNETIC FIELD. Mueller, Rolf W. Translated by R. C. Klewe for Univ. of California Lawrence Radiation Lab., Livermore, from Z. Angew. Phys., 18: 342-5(1965). 16p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

This article was previously abstracted from the original language and included in NSA as 19: 18647. (W.H.K.)

20379 CONCERNING THE DESIGN OF HIGH-FREQUENCY ION SOURCES. Tauth, T. Automat. Electron., 11: 120-5 (May-June 1967). (In Rumanian).

The main characteristics of high-frequency ion sources are reviewed and the criteria for the choice of parameters in the design of such sources to be used in accelerators are discussed. The physical construction of a source of this type is also detailed. (JPRS)

20380 SODIUM TUNGSTATE TARGETS FOR LOW ENERGY NUCLEAR PHYSICS EXPERIMENTS. Sowerby, B. D.; Sheppard, D. M. (Univ. of Alberta, Edmonton). Nucl. Instrum. Methods, 60: 358(Apr. 1968).

For low energy nuclear physics experiments requiring a sodium target, sodium tungstate has distinct advantages over other sodium compounds. (auth)

20381 SIMPLE HEATING ARRANGEMENT FOR USE IN NEUTRON SCATTERING EXPERIMENTS. Cocking, S. J. (Atomic Energy Research Establishment, Harwell, Eng.); McPhee, R. C.; Wigmall, G. D. J. Phys. E., 1: 367-8(Mar. 1968).

A simple heating arrangement for use in neutron scattering experiments up to temperatures of 900°C is described, together with its application to studies of liquid metal samples. (auth)

20382 SIMPLE BEAM POSITIONING SYSTEM FOR LOW ENERGY ELECTRONS. Dick, C. E. (National Bureau of Standards, Washington, D. C.); Marella, A. B.; Miller, W. C. Nucl. Instrum. Methods, 60: 346-8(Apr. 1968).

A servo system utilizing fabricated steering coils has been devised to hold the electron beam from a 4 MeV Van de Graaff accelerator on the entrance slit of a magnet system used for high momentum resolution. It performs extremely well. (auth)

20383 MODIFIED REGENERATIVE BEAM EXTRACTION SYSTEM FOR THE BUENOS AIRES 180 cm SYNCHROCYCLOTRON. Mayo, S.; Sametband, M. J. (Comision Nacional de Energia Atomica, Buenos Aires). Nucl. Instrum. Methods, 60: 261-4(Apr. 1968).

A beam extraction system was built according to de Kruiff and Verster's modified regenerative method. A radial gain of 5 cm per turn was measured at radius 89 cm corresponding to the entrance of the magnetic channel. A five sections magnetic channel was built and its transfer matrices were calculated. The extraction efficiency of the system is 10% when a 3 μA internal beam is accelerated. The vertical divergence of the external beam is negligible while the radial divergence is of the order of 0.005. (auth)

20384 STRUCTURE OF ERBIUM DEUTERIDE TARGETS FOR NEUTRON GENERATORS. Dow, P. A. (Aeon Labs., Surrey, Eng.); Briers, G. W.; Dewey, M. A. P.; Stark, D. S. Nucl. Instrum. Methods, 60: 293-6(Apr. 1968).

A technique has been developed for examining the microstructure of neutron generator target films of erbium deuteride, less than 6 μm thick, using both optical and electron metallography. Three phases can be present in these films, namely, ErD_2, free erbium, and erbium oxide, Er_2O_3. The average formulas for the films as determined by metallographic techniques agree favorably with the value derived from D_2 sorption measurements. (auth)

20385 EXTRACTION EFFICIENCY OF ELECTRONS IN A BETATRON. Nowicki, S. (Instytut Elektrotechniki, Warsaw). Arch. Elektrotech. (Warsaw), 16: 829-40(1967). (In Polish).

Equations for free oscillations of an electron in the plane of a stable orbit suitable for application at nonlinear focalizing forces and large oscillation amplitudes are derived. Formula for change of the parameter of path shape at crossing the extraction field by the electron has been derived. Definition of the extraction efficiency as well as methods for determining the probable and minimum efficiency are given. (auth)

20386 SEPARATION OF HIGH-ENERGY PARTICLES BY THE FIELD OF A PROGRESSIVE ELECTROMAGNETIC WAVE. Garault, Yves; Chatard-Moulin, Michel (CSU, Limoges, France. Domaine de la Borie, Limoges, France). Compt. Rend., Ser. A and B, 266: 259-61(Jan. 22, 1968). (In French).

The equations describing the transverse deviation due to a progressive wave are derived and it is shown that the separation of the high-frequency field is equal to $1/\lambda$ times that of the elec-

trostatic field. The effect of the deflector on the particles is equivalent to a pure angular deviation without displacement applied at the center of the structure. The case of an attenuated wave is considered. (J.S.R.)

20387 REACTION OF Li +^{4}He, Li +^{2}H, AND Li +^{1}H AS CYCLOTRON SOURCES OF FAST NEUTRONS. Daruga, V. K.; Dvukhsherstnov, V. G.; Dulin, V. A.; Krasnov, N. N.; Matusevich, E. S. At. Energ. (USSR), 24: 66-7(Jan. 1968). (In Russian).

The yield, energy, and angular distribution of fast neutrons ($E_n \geq 1$ MeV) from thick Li target bombarded by alpha particles, deuterons, and protons of 42 ± 1, 21 ± 0.5, and 22 ± 0.5 MeV, respectively, were investigated. The energy and angular distribution of neutrons from the Li target are presented in graphical form and the data on the yield are tabulated. (R.V.J.)

20388 MODELING OF ACCELERATION PROCESSES IN HIGH-CURRENT LINEAR ACCELERATORS ON ELECTRONIC COMPUTERS. Enal'skii, V. A.; Osipov, V. V. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 29-36(Sept.-Oct. 1967). (In Russian).

Charge currents in an electromagnetic field taking into account the interactions were calculated previously by V. A. Enal'skii (Trudy Matem. In-ta Akad. Nauk, SSSR, Vol. 74, (1966)), using numerical integration of equations of particle currents and numerical solution of the boundary value problem for elliptic-type equations. The same method was used for simulating, on computer, the acceleration process in a high-current linear accelerator. The approximation method was based on the method of large molecules describing large bunches of particles in motion in the proper field. The identical model was previously used for resolving problems of rarefied plasma during calculations of the large charge effect in accelerators, and, also, for klystron grouping of strong current beams during strong particle velocity modulations. (R.V.J.)

20389 ENGINEERING PROBLEMS ASSOCIATED WITH THE INTENSE NEUTRON GENERATOR. Guard, R. F. W. (Shawinigan Engineering Co., Ltd., Montreal); Stonehill, B. C.; Lewis, W. B. Eng. J. (Montreal), 51: 17-21(Jan. 1968).

Brazing a number of cavity sections to form an accurately aligned vacuum-tight accelerator tunnel 4000 ft long will require careful mechanical engineering. Cooling the thin meson target and the neutron target demands very efficient heat transfer design because of the small volume. Management of the large electrical power supply and remote handling equipment for the radioactive portions are some of the other problems involved. The project is still in the study stage. (F.S.A.)

20390 THIN-WALLED LIQUID HYDROGEN TARGET. Smolyankina, T. G.; Radkevich, I. A.; Sokolovskii, V. V. (Inst. for Theoretical and Experimental Physics, Moscow). Cryogenics, 7: 298(Oct. 1967).

A liquid hydrogen target was designed such that scintillation counters and spark chambers could be placed close to the operating volume of liquid hydrogen. This factor is important when recording secondary particles leaving the target over a large range of angles and momenta. A description of the target is given. (UK)

20391 SOURCE OF POLARIZED LITHIUM AND CESIUM IONS. Miers, R. E.; Anderson, L. W. (Univ. of Wisconsin, Madison). Rev. Sci. Instrum., 39: 336-40(Mar. 1968).

A source for polarized Li^+, Li^{++}, Cs^+, Cs^{++}, and Cs^{+++} ions is described. The ions are produced by electron bombardment of polarized Li^0 or Cs^0 atoms. The ion currents obtained are 3.3×10^{-8} A Li^+, 1.3×10^{-9} A Li^{++}, 6.0×10^{-8} A Cs^{+++}, 1.4×10^{-7} A Cs^{++}, and 6.6×10^{-7} A Cs^+. The background current of these ions is negligible. The polarization of the ions was not measured, but a discussion of the polarization is presented. This discussion leads to the conclusion that the nuclear vector polarization of $^7Li^+$ is about 25% and the electronic polarization of $^7Li^{++}$ is about 9.4%. Possible applications of the Li^{++} and Cs^{++} beams are discussed. An interesting result from this work is the average cross section for incident electrons of 200 to 325 eV energy for the process $e^- + Li^0 \rightarrow Li^{++} + 3e^-$, which has the value 3.5×10^{-18} cm^2. (auth)

20392 TERMINAL PULSING ON A LOW ENERGY ELECTROSTATIC ACCELERATOR. Chudleigh, P. W. (Univ. of Melbourne). Rev. Sci. Instrum., 39: 356-60(Mar. 1968).

The modification of a low energy electrostatic accelerator for terminal pulsing is described. Beam pulse durations as low as 3.7 nsec have been obtained at the target after acceleration. Under typical operating conditions the beam pulse duration is 4–5 nsec with peak currents of 100–200 μA and a pulse repetition period of 200 nsec. (auth)

20393 KYOTO UNIVERSITY TANDEM VAN DE GRAAFF. Sidei, Tsunahiko (Kyoto Univ.); Muto, Jiro; Kumabe, Isao; (and others). Mem. Fac. Sci., Kyoto Univ., Ser. Phys., Astrophys., Geophys., Chem., 32: 17-36(Sept. 1967).

A tandem type Van de Graaff accelerator at the Department of Physics in Kyoto University is described. Details of the accelerator, ion optical arrangement, structure of the columns, acceleration tubes, vacuum system, negative ion injection system, generation and control of the high voltage, beam analyzing magnet and switching magnet, high pressure gas system, building and general arrangement of the equipments are presented. The course of the construction and test of the machine is also described with the specifications of the machine and its performances. (auth)

20394 DEUTSCHE ELEKTRONEN-SYNCHROTRON (DESY): CHARACTERISTICS AND RESEARCH POSSIBILITIES. Jentschke, Willibald. Arbeitsgemeinsch. Forsch. Landes Nordrhein-Westfalen, No. 153, 33-69(Nov. 4, 1964). (In German).

At first the organization of the foundation Deutsches Elektronen-Synchrotron DESY is briefly discussed and the principal features of the design of the 6 GeV electron accelerator are described. At the beginning of November 1964 an energy of 6.5 GeV was reached for the first time. 10^{13} electrons/sec were attained with an energy of 4 GeV. The general lay-out of the experiments is described and three of the experiments are explained in detail: experiments with an 80 cm hydrogen bubble chamber, investigations on the structure of protons and neutrons, and spark chamber experiment on the production of meson pairs in the reaction of a photon with a hydrogen nucleus. (auth)

20395 CASCADE GENERATOR TYPE 3-MeV ELECTRON ACCELERATOR. Oshima, Yunosuke (Japan Atomic Energy Research Inst., Tokyo); Suematsu, Shigeru. Hitachi Hyoron, 49: 21-5(July 1967). (In Japanese).

The powerful, cascade generator type, 3 MeV electron accelerator has been constructed in Takasaki Research Establishment, of the Japan Atomic Energy Research Institute. A high-voltage generating circuit of the symmetrical type is employed, and the number of stages is 20, insulated by a high-pressure gas. The maximum accelerating potential is 3 MeV, and the maximum accelerating current is 5 mA. To increase the voltage efficiency, a plural coil compensation is employed. The electron accelerator attained a maximum radiation output of 15 kW in September 1966. A description is made of this accelerator, in the following sections: the cascade power-source circuit; the components of the accelerator (dc high-voltage generator, electron gun and accelerating tube, beam scanner, control and protective devices); and, main characteristics (voltage efficiency, accelerating voltage, electron beam). (NSA of Japan)

20396 SIZE OF THE PROTECTIVE ZONE AROUND PROTON ACCELERATORS. Lebedev, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Gig. Sanit., 9: 97-9(Sept. 1967). (In Russian).

The radiation field outside the housing of an accelerator is due primarily to fast neutrons. The total neutron dose for $E_n <$ 20 MeV) as a function of distance satisfies the following empirical equation: $D(r) \approx K D_0 r^{-2} \exp(-r/\lambda_{ef})$. Here D(r) is the radiation dose at a distance r from the source; D_0 is the radiation dose at the initial point (near the protective wall); λ_{ef} is the effective neutron attenuation length (equal to 391 m). The neutron dose as a function of distance is given for barrier geometry and for shielding from all sides. A formula is given for decreasing the radiation dose a factor of K times in case of a barrier of height k. With a reading of 0.3 mrad/hr at the surface, a distance of 300 m is required to attenuate the neutron dose a factor of 50. (TTT)

20397 DEVICE FOR PRODUCING A CHARGED-PARTICLE BEAM OF SHORT PULSE. Takeda, Yasutsugu (to Hitachi Ltd.). Japanese Patent 1967-12035, July 8, 1967. Filed Nov. 15, 1965.

By the method proposed, charged-particle beams of extremely short pulses can be obtained easily. The device consists of a charged-particle source; an electrode for controlling a charged-particle current; a charged-particle accelerating electrode; a pulse transformer for supplying an accelerating pulsed-voltage to the beam generator; the first pulsed-power source; a coaxial-cable secondary-winding, excited by the first pulsed-power source, one end of which is connected to the charged-particle current control electrode, and the other to the second pulsed-power source for producing the pulses of triangular (or similar) wave-shape to draw out a charged-particle beam. And, the respective windings in the device are prepared, so as to satisfy the equation $|V_{co}| = |V_0| + (n-1)|V_{gi}|$, where V_{co} is the pulsed voltage between the ends of the coaxial-cable secondary-winding, produced by the first pulsed-power source; V_0 is the charged-particle accelerating voltage; V_{gi} is the short-pulse voltage to be applied between the charged-particle source and the control electrode; and, nV_{gi} ($n > 0$) is the peak value of the (output) pulses, produced by the second pulsed-power source. (NSA of Japan)

20398 FERRITE ADJUSTABLE KICKER MAGNET FOR EXTRACTING BEAMS OF CHARGED PARTICLES. Forsyth, E. B. (to United States Atomic Energy Commission). U. S. Patent 3,375,452. Mar. 26, 1968.

Kicker magnets for extracting beams of charged particles from accelerators are described. Ferrite blocks are provided that selectively move toward and away from stationary ferrite blocks having stationary conductors thereon for producing particle-ejecting high magnetic fields, whereby the blocks selectively form a small clearance opening for a small diameter high energy beam at ejection and move apart to permit the blocks to receive and transmit low energy beams that are injected into the accelerator with large beam diameters. (AEC)

20399 ACCELERATION OF HEAVY PARTICLES. Courant, E. D. (to United States Atomic Energy Commission). U. S. Patent 3,374,378. Mar. 19, 1968.

A method of accelerating charged particles heavier than protons in existing high energy linear and cyclic proton accelerators is described. It consists of injecting the heavy particles sequentially into the linear and cyclic accelerators at pre-selected relatively low velocities, and exposing the particles to a high frequency electric accelerating field in the cyclic accelerator wherein the frequency of the accelerating field is made equal to different pre-selected harmonics of the revolution frequency of the particles in the cyclic accelerator. (AEC)

20400 MAGNETIC INDUCTION ACCELERATOR WITH MEANS TO DEFLECT ACCELERATED ELECTRONS TO AN X-RAY TARGET. Kerst, Donald W. (to United States Atomic Energy Commission). U. S. Patent 3,374,356. Mar. 19, 1968.

A method and apparatus for obtaining single pulse, high energy x rays from a magnetic induction accelerator having a known and adjustable timed relationship in respect to a phenomenon being studied are described. The x rays are produced by the introduction of a single burst of electrons, acceleration of these electrons in an equilibrium orbit by the increasing magnetic field, and the impinging of these accelerated electrons on a suitable target in response to pulsing of the orbit expansion circuit. (AEC)

20401 CHARGED PARTICLE ACCELERATOR. Brannen, E.; Forelich, R. (to Canadian Patents and Development Ltd.). Canadian Patent 775,275. Jan. 2, 1968.

Energy is supplied to a rotating cloud of electrons as they make repeated passage through an electromagnetic resonant cavity. By ensuring that the field in the drift spaces is at a low value the vagaries of the racetrack configuration may be overcome. The free field spaces are fitted with magnetic shields which provide a uniform field and accurately calculable drift time. The magnetically permeable materials in the drift spaces are pierced and provide passages for the charged particles during each orbit. The field in these passages is very low in comparison to the guide field across the pole faces. (F.S.A.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 18740, 20041, 20096, 20104, 20345, 20384, 20387, 20389, 20450, 20497, 20565, 20566, 20779, and 20931.

20402 (AEEW-M-676) LECTURES ON NEUTRON TRANSPORT THEORY. Newmarch, D. A. (Atomic Energy Establishment, Winfrith (England)). Apr. 1966. 57p. Dep. CFSTI. UK.

An introduction to the derivation, solution, and application of the neutron transport equation is presented. (D.C.W.)

20403 (CONF-680307-14) CHARACTERISTICS OF VARIOUS ISOTOPES FOR SANDWICH FOIL MEASUREMENTS OF NEUTRON SPECTRA. Connolly, T. J.; de Kruijf, F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). [1966]. 11p. Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

The sandwich method involves activation of foils of a single isotope in multiple layers. The difference in specific activity of two such foils can be related to the neutron flux in the narrow energy interval or intervals in which self-shielding occurs. An analysis is made of several isotopes relative to their potential for yielding spectrum information in the 1 to 10^4 eV region via the sandwich technique. The analysis involves an approximate relation giving the activation of individual foils in a multiple-layer stack as a function of the activation of single foils of different thicknesses. Activation in the latter foils is calculated by a standard effective resonance integral analysis. Input information includes both resolved and unresolved resonance parameters. The results give for each isotope the magnitude of the activation difference relative to the total activation of a single foil and also the distribution of this difference between individual resolved resonances and between resolved and unresolved resonances. Independent variables include individual foil thickness, number of foils per sandwich, and the neutron spectrum. Spectra representative of both thermal and fast reactors are included. (auth)

20404 (CONF-680307-16) FISSPROD: A FISSION PRODUCT PROGRAM FOR THERMAL REACTOR CALCULATIONS. Lane, F. E.; Walker, W. H. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). [1966]. 9p. Dep. CFSTI. CAN.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

The program FISSPROD calculates the concentrations of about 200 fission product nuclides by setting up and solving a matrix equation. The nuclides are arranged in order of increasing A and Z to give a lower triangular matrix with non-zero elements near the diagonal, permitting concentrations to be calculated one at a time. The present input includes all ground state and metastable nuclides with half-lives exceeding ~5 hrs between masses 76 and 166. The following data are given for each nuclide: thermal cross section and resonance integral for neutron capture to the metastable and ground states of the next higher mass isotope; decay constant for β decay to the metastable and ground states of the next lower charge isobar; decay constant for an isomeric transition (metastable states only); and yields in the thermal neutron fission of ^{233}U, ^{235}U, ^{239}Pu, and ^{241}Pu and fast fission in ^{238}U. Comparisons of FISSPROD calculations with pile oscillator determinations of fission product cross sections in irradiated ^{233}U, ^{235}U, ^{239}Pu, and ^{241}Pu have been made. The calculated cross sections are lower than measured values for MTR-irradiated ^{235}U, but within the estimated errors, and are appreciably greater than values obtained at Chalk River. (auth)

20405 (CONF-680307-17) THERMAL REACTOR ABSORPTION CROSS SECTIONS OF RADIOACTIVE NUCLIDES. Mowatt, R. S.; Walker, W. H. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). [1968]. 11p. Dep. CFSTI. CAN.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

A depletion method for measuring absorption cross sections of radioactive fission products is described. For most radioactive fission products the method is capable of accuracies which lead to negligible uncertainties in reactivity calculations. Using this method the effective cross sections for thermal reactor neutrons of ^{149}Pm and ^{151}Pm were determined to be 1000 ± 400 barns and <700 barns, respectively. (auth)

20406 (FEI-85) VREMENNYE I ENERGETICHESKIE KHARAKTERISTIKI RASPREDELENIYA NEITRONOV VYLETAYUSHCHIKH IZ VODORODOSODERZHASHCHIKH RADIATOROV. RASPREDELENIE VREMENI POGLOSHCHENIYA NEITRONOV V SIL'NO-POGLOSHCHAYUSHCHEI SREDE. (Time and Energy Distribution Characteristics of Neutrons Emitted From Hydrogen-Containing Radiators. Neutron Absorption Time Distribution in Strongly Absorbing Media). Broder, D. L.; Kutuzov, A. A.; Kham'yanov, L. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1967. 14p. (In Russian). Dep.

Results obtained using the Monte Carlo method are presented for the case of a neutron source with a Maxwellian spectrum at various thicknesses of moderating radiator. Results are included of the absorption time distribution for neutrons at various energies in layers consisting of a mixture of water and boron. It was found that at the optimum (3 cm) thickness of the water layer, the moderated neutron spectrum virtually coincides with the Fermi spectrum. ^{10}B economies can be attained by addition of water in the cases when some deterioration of the time characteristics is permissible, without fundamentally affecting the efficiency of a detector. (auth)

20407 (GA-8286) DCALC: A SUBROUTINE FOR ONE-DIMENSIONAL NEUTRON DIFFUSION THEORY CALCULATIONS. Wagner, M. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 17, 1967. Contract AT(04-3)-167. 85p. Dep. CFSTI.

The one-dimensional neutron diffusion theory routine DCALC, which is shared by the FEVER-7, GASP-7, and TEMCO-7 programs, is described. The methods that are used to solve the multigroup difference equation are outlined, and a FORTRAN listing of the subroutine is included. (D.C.W.)

20408 (GA-8380) SESH: A FORTRAN IV CODE FOR CALCULATING THE SELF-SHIELDING AND MULTIPLE SCATTERING EFFECTS FOR NEUTRON CROSS SECTION DATA INTERPRETATION IN THE UNRESOLVED RESONANCE REGION. Froehner, F. H. (Gulf General Atomic, Inc., San Diego, Calif.). Jan. 3, 1968. Contract AT(04-3)-167. 90p. Dep. CFSTI.

The computer program SESH, which uses Monte Carlo methods to calculate resonance self-shielding and multiple scattering effects as required for the interpretation of neutron capture and self-indication data in the region of unresolved resonances, is described. The program also calculates average transmissions for the analysis of neutron transmission data in the region of unresolved resonances. The calculations are based on level statistics. An example of a SESH calculation is given, as is a listing of the SESH code. (D.C.W.)

20409 (GA-8449) INTEGRAL NEUTRON THERMALIZATION. Quarterly Progress Report for the Period Ending December 31, 1967. Beyster, J. R.; Borgonovi, G. M.; Gozani, T.; (and others) (Gulf General Atomic, Inc., San Diego, Calif.). Jan. 15, 1968. Contract AT(04-3)-167. 46p. Dep. CFSTI.

Theoretical studies included the completion of tests of scattering laws for diphenyl and for zirconium hydride based on force constant models. These scattering laws are now ready for inclusion in the ENDF. A model for UO_2, similar in many respects to the zirconium hydride model, is nearing the testing stage. The first principles calculation of beryllium lattice dynamics has been completed. Other theoretical work includes improvements to the DSZ code for calculation of slowing-down sources. The increasing sophistication in theoretical scattering laws is closely related to improvements in precision and scope of experimental measurements. Plans are given for angular measurements from single beryllium crystals that will provide a severe check of theoretical models incorporating coherent effects. Analysis of total cross section data for water in terms of the parameter $\overline{T}$ was carried out. The resultant $\overline{T}$ agrees with the value calculated from the Haywood II phenomenological water kernel. A more detailed analysis of neutron spectra measured previously in ^{235}U and ^{238}U spheres was done, some discrepancies with theory being noted. The sensitivity of theoretical calculations to cross section sets together with the precision of the spectral data indicate the usefulness of these measurements as checks on theoretical work. The sensitivity of the results of kinetic studies in ^{238}U to inelastic neutron scattering was investigated by comparing experimental results to calculations with a simplified Monte Carlo code. Further evaluation of the intermediate energy detector was performed, with the result that the efficiency has turned out to be lower than had been anticipated. Methods of improving the efficiency are now being investigated. Count rate losses for the El Dorado analyzer coupled to the CDC 1700 computer were also analyzed. (D.C.W.)

20410 (GA-8466) NEUTRONIC MEASUREMENTS IN NON-CRITICAL MEDIA. Stevens, C. A. (Gulf General Atomic, Inc., San Diego, Calif.). [1967]. Contract AT(04-3)-167. 34p. (CONF-680307-19). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

Several types of subcritical experiments that are intended to provide integral checks of cross sections and computational methods in fast reactors and fast neutron shielding are discussed. These include studies of the time response to a pulsed neutron source, steady-state neutron spectrum measurements, and transmission measurements. The methods which are used to analyze these experiments are described, with the emphasis placed on what cross section information can be extracted from them. A description of how cross section averaging procedures are actually performed in some of the more sophisticated codes designed for this purpose is included. (auth)

20411 (IAE-1216) ANIZOTROPIYA SPEKTRA NEITRONOV V VODE VBLIZI POGLOTITELYA. (Neutron Spectrum Anistropy in Water Close to an Absorber). Ishmaev, S. N.; Sadikov, I. P.; Chernyshov, A. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1966. 28p. (In Russian). Dep.

An experimental installation based on a linear accelerator was used to measure the space, energy, and angular distribution of neutrons in water near a flat Cd surface. A method is described for measuring stationary neutron spectra with the aid of a chopper rotating in phase with the accelerator starter. The results of measurements of the space relation of the spectra of neutrons proceeding in the opposite directions with respect to the absorber surface show the existence of a strong spectrum anisotropy close to the absorber surface. The results of measurements of the angular dependence of neutron spectrum near an absorber are given. It is shown that the anisotropy of neutron scattering in water exerts a very strong effect on the neutron spectrum at the absorber interface. (auth)

20412 (JPRS-43682) SYMPOSIUM ON NEUTRON THERMALIZATION AND REACTOR SPECTRA, IAEA. Translation of Eleven Papers from Simpozium po Termalizatsii Neytronov i Reaktornym Spektram (Mezhdunarodnoye Agentstvo po Atomnoy Energii), Ann Arbor, July 17-21, 1967. 222p. CFSTI.

Separate abstracts were prepared for the 11 papers included. (D.C.W.)

For abstracts of individual papers see: 20413-20423.

20413 (JPRS-43682, pp 1-42) AVERAGE NEUTRON DENSITY IN NONHOMOGENEOUS MEDIA. Stepanov, A. V. Translated from Simpozium po Termalizatsii Neytronov i Reaktornym Spektram (Mezhdunarodnoye Agentstvo po Atomnoy Energii), Ann Arbor, July 17-21, 1967.

The passage of neutrons through nonhomogeneous media which may be described by means of Boltzmann equation with fluctuating parameters was investigated. An approximate equation for the neutron flow averaged over the fluctuations within the medium and applicable in the case of a small magnitude of fluctuations was derived. The analysis of the time and energy dependence of the average of the neutron flow was carried out. The analytical expressions for the relaxation constants of the neutron distribution were found. The periodic reactor lattice was investigated as an example of a nonhomogeneous medium. (auth)

20414 (JPRS-43682, pp 43-62) METHODS OF SOLVING PROBLEMS IN NEUTRON THERMALIZATION THEORY. Mayorov, L. V.; Trukhanov, G. Ya. Translated from Simpozium po Termalizatsii Neytronov i Reaktornym Spektram (Mezhdunarodnoye Agentstvo po Atomnoy Energii), Ann Arbor, July 17-21, 1967.

Some semianalytical methods for solving the kinetic equation are outlined. As examples, the calculation of the spectrum of thermal neutrons in an infinite medium with sources in the high-energy region and the calculation of the criticality of a finite flat heterogeneous lattice with identical cells are treated in a demonstration of the power of such techniques. (D.C.W.)

20415 (JPRS-43682, pp 63-80) ANISOTROPY OF NEUTRON SPECTRA IN WATER NEAR AN ABSORBER. Ishmaev, S. N.; Liman, G. F.; Mayorov, L. V.; Sadikov, I. P.; Chernyshov, A. A.; Bryzgalov, V. I. Translated from Simpozium po Termalizatsii Neytronov i Reaktornym Spektram (Mezhdunarodnoye Agentstvo po Atomnoy Energii), Ann Arbor, July 17-21, 1967.

Measurements of the spatial-energy-angular distribution of neutrons in water near a plane cadmium surface were carried out on an experimental device mounted on a linear accelerator. The methodology of measurements of stationary neutron spectra by means of a chopper whose rotation is in phase with the start of the accelerator is described. The results of the measurements of the spatial dependence of the spectra of neutrons moving in two opposite directions, from the absorber and towards the absorber, show that there exists a strong spectral anisotropy of neutrons near the absorbing surface. The numerical solutions of the kinetic (using the Nelkin model for water) yielded the angular special-energy distribution of neutrons which is then compared with experimental data. The influence of the moderator model and the neutron scattering anisotropy in water on the result was analyzed. (auth)

20416 (JPRS-43682, pp 81-105) A STUDY OF INELASTIC SCATTERING OF NEUTRONS IN GRAPHITE FOR VARIOUS TEMPERATURES. Eremeev, I. P.; Mostovoy, V. I.; Sadikov, I. P.; Severov, M. N.; Chernyshov, A. A. Translated from Simpozium po Termalizatsii Neytronov i Reaktornym Spektram (Mezhdunarodnoye Agentstvo po Atomnoy Energii), Ann Arbor, July 17-21, 1967.

The results of the measurement of double differential cross sections of neutron scattering in reactor graphite at temperatures of 15, 490, 1,000, and 1,370°C are presented. The measurements were carried out at the VVP-M reactor on an experimental device designed for the study of inelastic scattering of slow neutrons. The monochromatization and chopping of the primary beam of neutrons are carried out by means of a monocrystal and a mechanical chopper. The scattered radiation is analyzed by energies by the time-of-flight method which is carried out simultaneously at 8 angles within the 10 to 115° interval. The newly gathered data are presented in the form of scattering cross sections S(E,H) which are compared with theoretical results obtained on the basis of the frequency spectrum proposed by Egelstaff. (auth)

20417 (JPRS-43682, pp 106-22) THEORY OF DENSITY DAMPING OF NEUTRONS FROM A PULSE SOURCE IN A CONFINED MODERATOR. Kazarnovskii, M. V.; Mayorov, L. V.; Yudkevich, M. S. Translated from Simpozium po Termalizatsii Neytronov i Reaktornym Spektram (Mezhdunarodnoye Agentstvo po Atomnoy Energii), Ann Arbor, July 17-21, 1967.

A method for analyzing the time dependence of the distribution of neutrons from a pulsed source within a confined moderator is outlined. The technique can be used to determine the time dependence for real moderators and for arbitrary intervals of time. (D.C.W.)

20418 (JPRS-43682, pp 123-36) NEUTRON SPECTRA IN A TWO-REGION GRAPHITE-WATER SYSTEM. Abdullaev, Kh. Sh.; Bryzgalov, V. I.; Dikarev, V. S.; Liman, G. F.; Mayorov, L. V.; Mostovoy, V. I.; Taraban'ko, V. A. Translated from Simpozium po Termalizatsii Neytronov i Reaktornym Spektram (Mezhdunarodnoye Agentstvo po Atomnoy Energii), Ann Arbor, July 17-21, 1967.

The results of calculations and measurements of the spatial-energy distribution of thermal neutrons in graphite-water systems are presented. Neutron spectra were measured at graphite and water temperatures, respectively, of 133 and 297, 133 and 343, 303 and 303, 359 and 304, and 443 and 294°K. (D.C.W.)

20419 (JPRS-43682, pp 137-49) USE OF SYSTEMS OF LAGUERRE POLYNOMIALS AND ASSOCIATED FUNCTIONS FOR THE SOLUTION OF CERTAIN THERMALIZATION PROBLEMS. Laletin, N. I.; Pasynkov, I. G. Translated from Simpozium po Termalizatsii Neytronov i Reaktornym Spektram (Mezhdunarodnoye Agentstvo po Atomnoy Energii), Ann Arbor, July 17-21, 1967.

The calculation of the spectrum of slow neutrons resulting from the moderation of fast neutrons that are generated near the region under consideration and have energies much larger than kT, where T is the temperature of the medium and k is the Boltzmann constant, is considered. It is shown that by complementing the systems of Laguerre polynomials with systems of associated functions, a more satisfactory determination of the expansion coefficients can be made without restricting the treatment to the case of the heavy gas operator. (D.C.W.)

20420 (JPRS-43682, pp 150-64) FINDING SOLUTIONS TO CERTAIN TRANSFER PROBLEMS. Lebedev, V. I. Translated from Simpozium po Termalizatsii Neytronov i Reaktornym Spektram (Mezhdunarodnoye Agentstvo po Atomnoy Energii), Ann Arbor, July 17-21, 1967.

The KP method for the iterative solution of multigroup transport equations with degenerate scattering indicatrices is outlined and evaluated. (D.C.W.)

20421 (JPRS-43682, pp 165-78) STUDY OF NEUTRON THERMALIZATION IN WATER AT DIFFERENT TIMES. Ishmaev, S. N.; Mostovoy, V. I.; Sadikov, I. P.; Tolmacheva, L. A.; Chernyshov, A. A. Translated from Simpozium po Termalizatsii Neytronov i Reaktornym Spektram (Mezhdunarodnoye Agentstvo po Atomnoy Energii), Ann Arbor, July 17-21, 1967.

The results of experiments during a study of the thermaliza-

tion process of neutrons in water at different times were in substantial disagreement with the theoretical calculations. In conjunction with this, the methodology for the measurement and processing of the results was improved and new investigations of the process leading to the establishment of the equilibrium spectrum of neutrons in time within a large water system near an almost point pulsed source of fast neutrons were carried out. The influence of neutron diffusion on the process of thermalization during the total time needed for the establishment of the equilibrium spectrum at various distances from the source was also studied. (auth)

20422 (JPRS-43682, pp 179-98) MEASUREMENT OF NEUTRON PULSE DECAY IN SMALL SLUGS OF BERYLLIUM AND BERYLLIUM OXIDE. Zhezherum, I. F. Translated from Simpozium po Termalizatsii Neytronov i Reaktornym Spektram (Mezhdunarodnoye Agentstvo po Atomnoy Energii), Ann Arbor, July 17–21, 1967.

Decay constants were measured for neutron pulses in 20 Be blocks with geometrical B^2 parameters between 0.0213 and 0.097 cm^{-2} and in 27 BeO blocks with B^2 values between 0.011 and 0.058 cm^{-2}. The dependence of the decay constants on the geometrical B^2 parameter was studied, and diffusion parameters were derived from the data. (D.C.W.)

20423 (JPRS-43682, pp 199-222) PF-4 EXPERIMENTAL EQUIPMENT FOR STUDYING NEUTRON ENERGY SPECTRA. Kuznetsov, V. A.; Mogil'ner, A. I.; Bankrashkova, M. Ya.; Zakharkin, I. I.; Ilyasova, G. A.; Semenov, E. F.; Somov, I. E.; Shvetsov, D. M.; Yudkevich, M. S. Translated from Simpozium po Termalizatsii Neytronov i Reaktornym Spektram (Mezhdunarodnoye Agentstvo po Atomnoy Energii), Ann Arbor, July 17–21, 1967.

A time-of-flight facility for studying the energy distributions of neutrons in critical assemblies, subcritical assemblies, and nonmultiplying moderator assemblies is briefly described; and some results of studies of neutron energy spectra in Be and in hydrogenous materials are summarized. (D.C.W.)

20424 (ORNL-tr-1849) CALCULATION OF POSITION-DEPENDENT NEUTRON SPECTRA IN WATER–IRON–WATER SHIELD CONFIGURATIONS AND THE RELATIONS OF THE DIFFUSION APPROXIMATION TO EXACT TRANSPORT THEORY IN REGIONS OF STEEP FLUX GRADIENTS. Fiebig, R. Translated for Oak Ridge National Lab., Tenn., from report EUR-3472.d. 90p. Dep. CFSTI. JCL $8.10 fs, $2.90 mf.

The course of neutron spectra in a plane water-iron-water shield configuration was calculated with a neutron transport program BINE, and group constants for a multigroup diffusion calculation were derived from the results. The position dependence of the group constants was studied on the basis of the neutron fluxes and currents, and considerable differences were found compared to the group constants obtained with the P_1 approximation. The transport results were recalculated by means of group constants determined by region; the results are discussed. (auth)

20425 AN EXAMPLE FOR THE QUANTUM MECHANICAL DERIVATION OF NEUTRON TRANSPORT EQUATION. Meyer, K. (VEB Kombinat Kernenergetik, Berlin. Buero fuer Entwicklung und Projektierung Kerntechnischer Anlagen, Berlin). Kernenergie, 10: 364-5(Dec. 1967). (In German).

An example of the relation between a Markoff equation presented in a former publication and the transport equation is considered. The calculation of this example in age approximation shows that, in this case, the transport equation is a good approach. (auth)

20426 EPITHERMAL SPECTRUM DETERMINATION USING THE CADMIUM-DIFFERENCE METHOD. Dekker, A. L.; Grashuis, J. L. (Technological Univ., Delft, Netherlands). Nukleonik, 10: 278-9(Nov. 1967).

An epithermal neutron spectrum was measured using the cadmium-difference method. Ultra thin foils were used, the spectrum being divided into eight energy groups, for which the partial resonance integrals were computed. The resulting spectrum shows a $\Phi = \Phi_0/E^{0.99\pm0.04}$ dependence. (auth)

20427 THE ASYMPTOTIC P_N APPROXIMATION. Shulepin, V. S. At. Energy (USSR), 23: 551-2(Dec. 1967). (In Russian).

Calculation of the asymptotic and nonasymptotic portions in the solution of the neutron transport equation by the P_N approximation at large values of N represents a complex problem. It may be simplified by eliminating the condition of the continuity of the scaler currents at the boundary of the media, using only the asymptotic component. The equation of the continuity of unidirectional currents was used for the boundary conditions of two media; for the boundary toward the vacuum, the unidirectional current entering into the medium was taken as zero. The critical half-width values of a slab reactor with an infinite reflector were calculated and were tabulated using the P_{A1}, P_{A2}, and P_{A3} approximations. Comparison of the results with exact solutions indicated that the P_{A3} approximation yields satisfactory precision; it is much simpler to use than the P_3 approximation. This method may be thus used in calculations for multilayer reactors in which thin layers are adjacent to thicker layers, as measured in mean free path units. (TTT)

20428 THERMAL AND SUBTHERMAL NEUTRON SCATTERING. Mehringer, Wolfgang (Technische Hochschule, Munich). Z. Phys., 210: 434-56(1968).

Several problems in thermal and subthermal neutron scattering are considered, such as long-wave phonon multiple scattering, interference, reflection and inelastic small-angle scattering. A method for solving elastic scattering problems is given and is applied to the problem of diffraction from a plane slit. These investigations were partly motivated by experimental results, a discussion of which will be found in the appendix. Finally, as of special interest for experiments with extreme subthermal energies, the contribution of phonons to refraction and inelastic nuclear spin-flip scattering, such as by a ferromagnet, are discussed. (auth)

20429 FUNCTIONAL EXPANSION AND GREEN FUNCTION TECHNIQUES IN SCATTERING OF NEUTRONS BY AN ANHARMONIC CRYSTAL. Hoegberg, T. (Aktiebolaget Atomenergi, Studsvik, Sweden). Ark. Fys., 34: 121-38(1967).

The differential scattering cross section for the scattering of thermal neutrons by an anharmonic crystal is expanded in a functional series, which gives the cross section in terms of Green functions for the displacement operators. It is shown how the successive terms in the expansion can be related to the causal Green function and integral operators defined in its equation of motion. Explicit formulas carried out to second order are given for a crystal Hamiltonian where cubic and quartic anharmonic terms are retained. (auth) (Sweden)

20430 POLARIZATION EFFECTS IN SLOW-NEUTRON SCATTERING. III. NUCLEAR POLARIZATION. Schermer, R. I.; Blume, M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 166: 554-61(Feb. 10, 1968). (BNL-11668).

The theory of polarized-neutron scattering is extended to include the effects of nuclear polarization. General formulas for the cross section and the polarization of the scattered beam are given for arbitrary spin orderings. Several experiments which allow the determination of the spin dependence of the nuclear scattering amplitude are discussed. (auth)

20431 COHERENT SCATTERING OF SLOW NEUTRONS FROM HEAVY WATER. Kadotani, Hiroyuki (Tokyo Inst. of Tech.); Iijima, Shungo. J. Nucl. Sci. Technol. (Tokyo), 4: 625-7 (Dec. 1967).

Calculations are presented on the scattering law for heavy water which are made on the basis of Butler's model with experimentally determined acoustic frequency distribution. The necessary modification of Sjölander's approximation for application to the multiphonon process of interference scattering is also discussed. (S.F.L.)

20432 INTENSE NEUTRON GENERATOR. (to Atomic Energy of Canada, Ltd.). British Patent 1,103,978. Feb. 21, 1965. Priority date Apr. 27, 1965, Canada.

A high-flux neutron source is described in which a high-intensity proton beam strikes a flowing liquid lead-bismuth eutectic target, producing about 10^{19} neutrons/sec. (D.C.W.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 19137, 19733, 20201, 20483, 20485, 20578, 20640, 20681, 20771, and 20772.

20433 (JINR-P2-3705) O ZARYADOVOI ZAVISIMOSTI RADIUSOV TREKHNUKLONNYKH YADER. (On the Charge Dependence of the Three-Nucleon Nuclei Radii). Gerasimov, S. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 6p. (In Russian). Dep.

The charge dependence of the distribution radii of "odd" nucleons (the proton for ^{3}He and the neutron for ^{3}H) in the three-nucleon nuclei is discussed for the cross section of the ^{3}He and ^{3}H nuclear photodisintegration on the basis of the dipole sum rule and the model of the isotopic invariance violation. The result is compared with experiment. (auth)

20434 (JINR-P4-3717) $\alpha-\alpha$ RASSEYANIE V SLUCHAE NELOKAL'NOGO FAKTORIZUYUSHCHEGOSYA VZAIMODEISTVIYA. ($\alpha-\alpha$ Scattering for the Case of Non-Local Factoriz-

ing Interaction). Tkebuchava, F.; Chilashvili, G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 7p. (In Russian). Dep.

Alpha–alpha scattering is investigated taking into account the Coulomb interaction for the case of a nonlocal factorizing potential. The parameters of the interaction potential are found from the phase-shift analysis using the experimental values of the S phase in the interval E = 0.2 to 10 MeV. (auth)

20435 ELASTIC SCATTERING OF SEVERAL HYDROGEN AND HELIUM ISOTOPES FROM TRITIUM. Ivanovich, M.; Young, P. G.; Ohlsen, G. G. (Australian National Univ., Canberra). Nucl. Phys., A110: 441-62(1968).

The elastic scattering of protons, deuterons, ^{3}He, and ^{4}He particles from tritium was investigated for bombarding energies between approximately 3 and 11 MeV. Excitation functions were taken at several angles in each case, and angular distributions of d-^{3}H, ^{3}He-^{3}H and ^{4}He-^{3}H scattering were obtained. In addition, cross-section data from ^{3}He-^{3}He and ^{4}He-^{3}He elastic scattering and from the ^{3}H(d,α)n reaction are reported. A broad anomaly was observed in the d-^{3}H elastic scattering measurements corresponding to an excitation energy of approximately 19 MeV in ^{5}He. Two resonances were observed in the ^{4}He-^{3}H measurements corresponding to excitation energies of 4.65 and 6.79 MeV in ^{7}Li. A phase shift analysis of the ^{4}He-^{3}H data was performed, and spin and parity assignments of $^1/_2^-$ and $^5/_2^-$ were obtained for the two resonances. No sharp structure was observed in the p-^{3}H or ^{3}He-^{3}H excitation functions. (auth)

20436 INELASTIC ELECTRON SCATTERING FROM ^{4}He. Frosch, R. F.; Rand, R. E.; Crannell, Hall; McCarthy, J. S.; Suelzle, L. R.; Yearian, M. R. (Stanford Univ., Calif.). Nucl. Phys., A110: 657-73(1968).

The spectra of electrons scattered inelastically from ^{4}He were measured at incident energies from 150 to 400 MeV for scattering angles from 38 to 90°. Through the use of a liquid ^{4}He target, a high momentum resolution (≈0.25%) was obtained, and the 20-MeV 0^+ state of the α particle was observed for the first time in electron scattering. The excitation energy and the total width of this state were determined and are in good agreement with the results from other experimental methods. It was found that the total disintegration cross section appears to be smaller than $2(\sigma_p + \sigma_n)$ by more than an order of magnitude at the lowest $q^2 \approx 0.33$ fm^{-2}). In earlier work the assumption of a total cross section of $2(\sigma_p + \sigma_n)$ was found to be quite accurate for higher q^2. As a new result, the partial radiative width for the 0^+ state is determined to be Γ_{rad} = 1.1 ± 0.3 MeV. (auth)

20437 FINAL-STATE INTERACTIONS IN THE REACTIONS ^{3}He(^{3}He,2p)^{4}He AND T(^{3}He,np)^{4}He. Blackmore, E. W.; Warren, J. B. (Univ. of British Columbia, Vancouver). Can. J. Phys., 46: 233-41(Feb. 15, 1968).

Final-state interactions in the p-p and p-n systems, corresponding to the formation of the singlet states of the diproton and the deuteron, were observed in the reactions ^{3}He(^{3}He,2p)^{4}He and T(^{3}He,np)He, using two-dimensional energy analysis of the p-^{4}He coincidences. An incident ^{3}He energy of 1.50 MeV was used in these measurements. The interactions appear as an increase in the coincidence yield in the region of the p-^{4}He kinematic contours corresponding to a breakup in which the nucleons emerge with low relative energy. The validity of two approximate theories of final-state interactions, the Watson theory and the Phillips, Griffy, and Biedenharn density-of-states formalism, was checked by comparing their predictions with the observed energy spectra. (auth) (Canada)

20438 MEASUREMENT OF PROTON–PROTON POLARIZATION AT 20 MeV. Catillon, P.; Sura, J.; Tarrats, A. (Centre d'Etudes Nucleaires, Saclay, France). Phys. Rev. Lett., 20: 602-3(Mar. 18, 1968).

The (p,p) polarization asymmetry was measured at 20.2-MeV laboratory energy with an accuracy as good as ±0.001. The results are consistent with the phase-shift analyses at this energy. (auth)

20439 MEASUREMENT TO THE NUCLEAR RADIUS OF ^{4}He. Block, M. M.; Kenyon, I.; Keren, J.; Koetke, D.; Malhotra, P.; Mazur, P.; Walker, R.; Winzeler, H. (Northwestern Univ., Evanston, Ill.). Phys. Lett., 26B: 464-7(Mar. 4, 1968).

The impulse model of Block and Koetke (Northwestern University Report, No. 105 (1967)) was used to analyze some data on meson (π) elastic scattering by ^{4}He at 85, 129, 140, and 150 MeV/c in terms of the π-N phase shifts and a nuclear radius for ^{4}He. A value of 1.68 ± 0.05 F was obtained for the nuclear radius. (D.C.W.)

20440 STUDY OF THE REACTION ^{2}H(^{3}He,γ)^{5}Li AT $E_{^3He} \leq$ 5.5 MeV. Kraus, L.; Suffert, M.; Magnac-Valette, D. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Phys., A109: 593-602(1968). (In French).

The radiative capture of 2 to 5.5 MeV ^{3}He by deuterons was studied by measuring gamma transitions of about 17 MeV. The reaction ^{3}He(d,γ)^{5}Li was also observed between 1 and 5 MeV. Excitation curves are given for both cases and angular distributions for the first reaction only. The excitation curve at 90° shows a resonance at 16.6 MeV energy excitation in ^{5}Li with a total cross section of 38 μb and nonresonant capture at higher energies. In this experiment, no evidence is found for transitions to the first excited $p_{\frac{1}{2}}$ state of ^{5}Li. The one level approximation of S-matrix theory with constant background is applied to the analysis of the excitation curve. The level parameters $J^\pi = {}^3/_2{}^+$ are deduced. (auth)

20441 ELASTIC SCATTERING OF 14.2-MeV DEUTERONS BY DEUTERONS AND ^{4}He NUCLEI. Itoh, Hidehiko (Kyoto Univ.). Mem. Fac. Sci., Kyoto Univ., Ser. Phys., Astrophys., Geophys., Chem., 32: 37-48(Sept. 1967).

The differential cross sections for the elastic scattering of 14.2-MeV deuterons by deuterons were measured at angles between 13.5 and 60° in the laboratory system. The differential cross sections for the elastic scattering of 14.2-MeV deuterons by helium-4 nuclei were also measured at angles between 13.5 and 110° in the laboratory system. (auth)

20442 A STUDY OF PROTON–DEUTERON INTERACTIONS AT 46 MeV. Slaus, Ivo.; Verba, J. W.; Richardson, J. Reginald; Carlson, R. F.; Saylor, D. P. (Univ. of California, Los Angeles). pp 973-7 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The proton-deuteron interaction was extensively studied at 46 MeV. Angular distributions of elastic and inelastic scattering and correlation spectra in and out of the reaction plane were measured. Pronounced final-state interaction effects and quasifree processes were observed. The data were analyzed in terms of the spectator model, the Born approximation, and the Born approximation including the modification produced by final-state interactions. (auth)

20443 ANALYSIS OF THE REACTION D + P → P + P + N. Donovan, P. F. (Bell Telephone Labs., Inc., Murray Hill, N. J. Brookhaven National Lab., Upton, N. Y.); Mollenauer, J. F.; Zupancic, C.; Boyd, D. P.; Parker, P. D. pp 978-82 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Proton-proton coincidence data from the reaction d + p → p + p + n shows three rather strong peaks in the E_p vs E_p array. These are due to the formation of intermediate singlet deuterons and to a projectile-knockout reaction mechanism. Analysis of the shape of the singlet deuteron peaks yields a value for the singlet p-n scattering length of −24 ± 2F. (auth)

20444 ON THE REACTIONS d(n,γ)^{3}H AND d(p,γ)^{3}He. Bosco, B. (Univ., Cagliari, Italy. Ecole Normale Superieure, Orsay, France). pp 1007-11 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The effects of the interaction between nucleon and deuteron on the cross sections for the processes d(n,γ)^{3}H and d(p,γ)^{3}He are discussed on the basis of different models for the three-body system with a dispersive approach. It is found that, while these effects are almost independent from the description of the three-body state, they are reducing strongly the theoretical cross section. (auth)

20445 POLARIZATION OF 30- AND 50-MeV PROTONS ELASTICALLY SCATTERED FROM DEUTERONS. Gibson, W. R. (Queen's Univ., Belfast); Johnson, A. R.; McClatchie, E. A.; Megaw, J. H. P. C.; Griffiths, R. J. pp 1016-18 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Measurements were made of the polarization in the elastic scattering of 30- and 50-MeV protons from deuterons at forward scattering angles. There is a considerable discrepancy between the experimental angular distribution and that predicted by theory using the Chew approximation. (auth)

20446 FINAL-STATE INTERACTIONS IN THE d(p,pn)p REACTION. Jackson, W. R.; Emerson, S. T.; Chen, Y. S.; Valkovic, V.; Simpson, W. Dwain; Phillips, G. C. (Rice Univ., Houston, Tex.). pp 1019-22 of International Nuclear Physics

Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The ^{2}H(p,pn)p reaction was studied at a bombarding energy of 9.0 MeV and several coincidence detection angles using the Rice University Tandem Van de Graaff and computer analyzer system. The energies of the detected coincident particles were determined using a solid-state surface-barrier detector for the proton and time-of-flight measurement on the neutron. The data are discussed with regard to the observed final-state interactions. (auth)

20447 POLARIZATION IN ^{3}He–^{4}He SCATTERING NEAR 26 MeV. Boschitz, E. T.; Vincent, J. S. (Lewis Research Center, Cleveland). pp 1023-4 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Using the classical double scattering technique in which cms energies and angles are matched ($A = P^2$), the polarization of ^{3}He scattered by ^{4}He at $\theta_{c.m.} = 130°$ was measured near $E_{Lab} = 26$ MeV. The observed asymmetry was $A = 0.190 \pm 0.030$, which yields $|P| = 0.436 \pm 0.054$, indicating the usefulness of the ^{3}He-^{4}He scattering as a source of 26-MeV polarized ^{3}He particles. (auth)

20448 THE MAGNETIC MOMENT AND HFS ANOMALY FOR ^{3}He. Williams, W. L.; Hughes, V. W. (Yale Univ., New Haven). pp 1042-5 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

A high-precision measurement of the helium ratio of the nuclear magnetic moments of ^{3}He and ^{1}H was made by NMR techniques using a gaseous sample with the result $-\mu(^3\text{He})\,|_{\text{He}}/\mu(^1\text{H})|_{H_2} = 0.76178684 \pm 0.1$ ppm, uncorrected for magnetic shielding in helium and H_2. The derived HFS anomaly is $\delta_{^3\text{He}} = (167 \pm 12) \times 10^{-5}$. Implications for exchange currents are discussed. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 18710, 19110, 19137, 19733, 20113, 20127, 20497, 20513, 20576, 20578, 20640, 20681, 20682, 20696, 20711, 20728, 20760, and 20767.

20449 (CONF-680307–15) TOTAL NEUTRON CROSS SECTIONS OF ^{9}Be, ^{14}N, AND ^{16}O. Johnson, C. H.; Haas, F. X.; Fowler, J. L.; Martin, F. D.; Kernell, R. L.; Cohn, H. O. (Oak Ridge National Lab., Tenn.). [1968]. 8p. Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

Total neutron cross sections of some light nuclei, measured with sufficient energy resolution to resolve most of the resonances at energies between ~1.5 and 5.0 MeV are presented. These include the total cross section of ^{9}Be from 1.9 to 4.6 MeV with ~25-keV resolution, the total cross section of ^{14}N from 2.0 to 4.2 MeV with ~5-keV resolution, and the total cross section of ^{16}O from 1.80 to 3.65 MeV with ~2-keV resolution. (auth)

20450 (COO–7–0456) FAST NEUTRON ENERGY MEASUREMENTS. Davis, J. C.; Noda, F. T. (Wisconsin Univ., Madison). Mar. 1, 1968. Contract AT(11-1)-Gen-7. 7p. (CONF-680307–5). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

Neutron energies at which sharp resonances have been reported vary by as much as 200 keV for neutron energies around 7 MeV according to measurements at different laboratories. To investigate these differences the analyzing magnet of the Wisconsin Tandem Accelerator was recalibrated with an accuracy better than 0.1%. Energy loss and straggling were studied for Ni foils used as entrance windows for gas targets. The energies of some of the sharp structure in neutron total cross sections reported previously were measured with ^{7}Li(p,n), T(p,n), and D(d,n) neutrons. Neutron energies reported in Phys. Rev., 123: 209(1961) should be increased from 1 keV at 3.4 MeV to 22 keV at 7 MeV and from 10 keV just above 7 MeV to 83 keV at 16 MeV. Energies reported in Phys. Rev., 158: 1167(1967) should be increased from 6 keV at 4.5 MeV to 15 keV at 6 MeV and from 24 keV just above 6 MeV to 88 keV at 14 MeV. Neutron energies are determined to about 0.1%. (auth)

20451 (JINR–P4–3674) PRYAMYE I OBRATNYE FOTOYADERNYE REAKTSII NA YADRAKH ^{15}N I ^{15}O. (Direct and Inverse Photonuclear Reactions on ^{15}N and ^{15}O Nuclei). Zhusupov, M. A.; Eramzhyan, R. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 17p. (In Russian). Dep.

Direct and inverse photonuclear reactions on mirror ^{15}N and ^{15}O nuclei are considered in terms of a particle-hole approach taking into account the pair correlations of nucleons in nucleus. A wide maximum of the dipole transitions (in the range of 20 to 21 and 25 to 26 MeV) as well as "pigmi" resonances in the range of 20 MeV are given. Isospin structure of the resonance is studied. The "pigmi" resonance is due to the excitation of the states with $T = 1/2$, while the main maximum is due to the states with $T = 3/2$. The decay scheme of the dipole states of ^{15}N nucleus is calculated. It is shown that the contribution of a three-particle channel of disintegration is rather large. The inverse reactions ^{14}N(p,γ)^{15}O and ^{14}C(p,γ)^{15}N, emitting γ-quanta both into the ground and $I = 3/2^-$ excited state of ^{15}N and ^{15}O nuclei, are investigated. The resonances have different structure in these mirror nuclei. (auth)

20452 LEVEL STRUCTURE IN ^{9}Be AND ^{6}Li FROM ^{7}Li(^{3}He,p) ^{9}Be AND ^{7}Li(^{3}He,α)^{6}Li. Cocke, C. L. (California Inst. of Tech., Pasadena). Nucl. Phys., A110: 321-38(1968).

Proton and alpha-particle spectra from the ^{3}He bombardment of ^{7}Li were taken over a variety of bombarding energies and observation angles with the intent of exploring the level structure in the residual nuclei ^{9}Be and ^{6}Li. In ^{9}Be, previously unreported levels were found at excitations of 13.78 ± 0.03 MeV and 16.671 ± 0.008 MeV with widths of 590 ± 60 keV and 41 ± 4 keV, respectively. Two overlapping levels were found at 11.81 ± 0.02 MeV and 11.29 ± 0.03 MeV with widths of 400 ± 30 keV and 620 ± 70 keV, respectively. No evidence for previously reported levels at 7.94 and 9.1 MeV was found. The alpha-particle spectra show states in ^{6}Li at excitations of 0.0, 2.17 ± 0.02, 3.55 ± 0.02 and 5.34 ± 0.02 MeV. No evidence for states previously reported in this reaction at 4.3, 6.63, 7.40, 8.37, and 9.3 MeV was found. Alpha-particle groups from sequential decays through states in ^{8}Be were seen and identified. (auth)

20453 C–α ELASTIC SCATTERING AND STATES OF ^{16}O BETWEEN 9.16 AND 12.11 MeV. Clark, G. J.; Sullivan, D. J.; Treacy, P. B. (Australian National Univ., Canberra). Nucl. Phys., A110: 481-9(1968).

Elastic scattering of alpha particles from ^{12}C was measured for ^{16}O excitation energies between 9.26 and 12.11 MeV. The results were interpreted using a real phase-shift analysis; and parameters from single-level fits were assigned for broad 0^+, 1^-, and 3^- levels of ^{16}O. (auth)

20454 ^{14}N(n,α)^{11}B REACTION AT 14.1 MeV. Maxson, D. R.; Murphy, R. D.; Zatzick, M. R. (Brown Univ., Providence). Nucl. Phys., A110: 609-18(1968).

Natural N_2 gas was bombarded with 14.1-MeV neutrons, and alpha particles from ^{14}N(n,α)^{11}B reactions were observed with a telescope consisting of two proportional counters and a CsI(Tl) scintillator. Absolute differential cross sections were measured for the (n,α) transitions to the ground state and to the 2.14-MeV level of ^{11}B. The observed angular distributions were fitted with curves calculated using two-mode PWBAE, ^{3}He pick-up, and diffraction theories. (auth)

20455 A STUDY OF (α,n) REACTIONS ON ^{9}Be AND ^{13}C AT LOW ENERGIES. Davids, Cary N. (California Inst. of Tech., Pasadena). Nucl. Phys., A110: 619-36(1968).

Measurements of the thick target neutron yield from the reaction ^{13}C(α,n)^{16}O are described. The yield was determined for laboratory bombarding energies between 0.475 and 0.700 MeV using a stilbene scintillator neutron detector and pulse-shape discrimination to eliminate gamma rays. Stellar temperatures between 2.5 and 4.5×10^9°K are involved in this energy region. The neutron yield was used to determine the astrophysical cross-section factor S(E), which was found to fit a linear function in the interaction energy E; $S(E) = [(5.48 \pm 1.77) + (12.05 \pm 3.91)E] \times 10^6$ MeV · b (center-of-momentum system). The rate of the ^{13}C(α,n)^{16}O reaction is discussed with reference to neutron production in the helium-burning region of a star. Results are also presented of measurements carried out on the reaction ^{9}Be(α,n)^{12}C taken with a thin Be target. The bombarding energy range covered was from 0.340 to 0.680 MeV with excitation curves for the ground and first excited state neutrons being reported. Resonances were found at bombarding energies of $E_{lab} = 0.520$ MeV ($\Gamma \approx 55$ keV cms, $\omega\gamma = 3.79$ eV and $E_{lab} = 0.600$ MeV ($\Gamma < 4$ keV c.m., $\omega\gamma = 0.88$ eV cms). (auth)

20456 ENERGY LEVELS OF ^{17}O FROM ^{13}C(α,α_0)^{13}C AND ^{13}C(α,n)^{16}O. Kerr, G. W.; Morris, J. M.; Risser, J. R. (Australian National Univ., Canberra). Nucl. Phys., A110: 637-56(1968).

The ^{13}C(α,α)^{13}C cross sections at cms angles of 54.7, 90, 149.4, and 169.6 and ^{13}C(α,n)^{16}O cross sections at 0° were measured over

the range of energies from 3.5 to 6.5 MeV. Angular distributions for the $^{13}C(\alpha,n)^{16}O$ reaction were measured at a number of energies within this range. From a dispersion-theory analysis a consistent set of J^{π} and partial-width values have been obtained for eleven states of the compound nucleus ^{17}O with excitation energies between 9 and 10 MeV. (auth)

20457 $^{16}O(n,\alpha)^{13}C$ REACTION AT 14.1 MeV. Maxson, D. R.; Murphy, R. D. (Brown Univ., Providence). Nucl. Phys., A110: 555-60(1968).

Natural O_2 gas was bombarded with 14.1-MeV neutrons, and alpha particles from $^{16}O(n,\alpha)^{13}C$ reactions were observed with a telescope consisting of two proportional counters and a CsI(Tl) scintillator. Absolute differential cross sections were measured for the (n,α) transitions to the ground state of ^{13}C and to an unresolved triplet of known levels at excitation energies of 3.09, 3.68, and 3.86 MeV. Comparisons with previous observations were made, and the ground-state angular distribution was fitted with curves calculated according to two-mode PWBAE theory. (auth)

20458 ANGULAR DISTRIBUTIONS OF NEUTRONS FROM THE $^{7}Li(p,n)^{7}Be$ REACTION NEAR THRESHOLD. Bergstroem, A.; Schwarz, S.; Stroemberg, L. G.; Wallin, L. (Research Inst. of National Defence, Stockholm). Ark. Fys., 34: 153-67(1967).

Angular distributions are presented for neutrons from the reaction $^{7}Li(p,n)^{7}Be$ at proton energies between reaction threshold and 2.36 MeV. A ^{6}Li-glass scintillator and time-of-flight techniques were used for neutron detection. The integrated differential cross sections were normalized to published values. An analysis was made in terms of the Humblet–Rosenfeld S-matrix formalism for nuclear reactions. (auth) (Sweden)

20459 T = 2 STATES IN ^{16}N. Hensley, D. C.; Nettles, P. H.; Barnes, C. A. (California Inst. of Tech., Pasadena). Phys. Lett., 26B: 435-6(Mar. 4, 1968).

T = 2 levels were observed in ^{16}N at excitations of 9.928 and 11.701 MeV in the reaction $^{14}C(^{3}He,p^{16}N$. Analysis of the proton angular distributions indicates 0^{+} for the 9.928-MeV level and 1^{-} or 2^{+} for the 11.701-MeV level. (auth)

20460 STUDY OF THE THREE-BODY REACTION $^{11}B(p,\alpha\alpha)\alpha$ FROM 150 keV TO 2 MeV. Giorni, A.; Engelhardt, D.; Cavaignac, J. F.; Longequeue, J. P.; Bouchez, R. (Univ., Grenoble, France. CEN, Grenoble, France). J. Phys. (Paris), 29: 4-8(Jan. 1968). (In French).

Correlations between the three α particles from ^{11}B + p at 163 keV ($^{12*}C2^{+}$), at 680 keV (2^{-}), 1.4 MeV (1^{-}), and 2.0 MeV (0^{+}) were analyzed with a two-parameter analyzer. The 3α decay is a mainly sequential process via the ^{8}Be (0^{+}) and (2^{+}) resonances; the width of the ^{8}Be (2^{+}) resonance is smaller ($\Gamma \approx 1$ MeV) than the value obtained by $\alpha-\alpha$ scattering. (auth)

20461 STUDY OF THE EXCITED STATES OF ^{11}C UP TO 8.43 MeV AND OF THE 5.03 AND 6.81 MeV LEVELS OF ^{11}B BY A PARTICLE-GAMMA CORRELATION TECHNIQUE. Earwaker, L. G.; Montague, J. H. (California Inst. of Tech., Pasadena). Nucl. Phys., A109: 507-28(1968).

Particle–gamma coincidence measurements were used to study the energy levels of ^{11}C up to 8.43 MeV excited by the $^{12}C(^{3}He,\alpha)^{11}C$ reaction and the levels in ^{11}B at 5.03 and 6.81 MeV excited by the $^{8}Be(^{3}He,p)^{11}B$ reaction. Branching ratios were obtained for the two ^{11}B levels and the bound levels in ^{11}C. The ratios of radiative width to total width for the unbound 8.10 and 8.43 MeV ^{11}C levels were determined as $\Gamma_{\gamma}/\Gamma < 0.04$ and 0.2 ± 0.1, respectively. The correlation technique of Litherland and Ferguson was used to determine the spins of the bound levels in ^{11}C and the multipole mixing ratios for many of the transitions. Spin assignments of $\frac{1}{2}$, $\frac{5}{2}$, $\frac{3}{2}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{5}{2}$, and $\frac{3}{2}$ have been made to the levels at 2.00, 4.32, 4.81, 6.35, 6.49, 6.90, and 7.50 MeV. Probable spins of $\frac{3}{2}$ and $\frac{1}{2}$ have been assigned to the 5.03- and 6.81-MeV levels in ^{11}B. The results are compared with previous work and with theoretical predictions. (auth)

20462 THE REACTIONS $^{6}Li(^{3}He,^{3}He_0)^{6}Li$, $^{6}Li(d,d_0)^{6}Li$, $^{7}Li(d,d_0)^{7}Li$, AND $^{6}Li(^{3}He,d_{0\ 1})^{7}Be$. Luedecke, H.; Tan, Wan-tjin; Werner, H.; Zimmerer, J. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A109: 676-88(1968).

Angular distributions for ^{3}He ions elastically scattered from ^{6}Li were measured for nine bombarding energies between 8 and 20 MeV. The elastic scattering of deuterons by ^{6}Li and ^{7}Li was studied at 11.8 MeV. Optical model-parameters of the type $V \approx 50$ MeV × A (projectile) and $r_w > r_v$ were obtained, which are in fair agreement with parameter sets of the same type found for neighboring nuclei. The parameters for the ^{3}He elastic scattering show a smooth variation with incident energy in the range 8 to 20 MeV. Differential cross sections for $^{6}Li(^{3}He,d)$ to the ^{7}Be ground state and the first excited state (0.43 MeV) were measured at 8, 10, 14, and 18 MeV. DWBA calculations using optical parameters derived from the elastic scattering $^{6}Li + ^{3}He$ and $^{7}Li + d$ yield only a qualitative description of the measured angular distributions. The ratio S*/S of the spectroscopic factors corresponding to $^{7}Be(0.43)$ and $^{7}Be(g.s.)$ is in fair agreement with the values derived from $^{6}Li(d,n)$ and $^{6}Li(d,p)$ reactions. (auth)

20463 MEASUREMENT OF THE PRODUCTION CROSS SECTION OF ^{11}C FROM NATURAL CARBON FOR 385 MeV PROTONS. Andrews, P. T.; Butler, P. G.; Christy, A.; James, A. N.; Kirkby, P.; Lowe, B. G.; Renwick, B. W. (Univ. of Liverpool). Nucl. Phys., A109: 689-93(1968).

The production cross section of ^{11}C from natural carbon for 385 MeV protons was measured to be 36.7 ± 0.6 mb. (auth)

20464 STRIPPING AND COMPOUND-NUCLEUS INTERFERENCE IN THE REACTION $^{16}O(d,p_1)$ ($E_d < 1.2$ MeV). Nguyen Van Sen, M. (Univ., Grenoble, France); Longequeue, N.; Chan, Tsan Ung; Beaumevieille, M. H.; Yaker, M. J. Phys. (Paris), 29: 15-18(Jan. 1968). (In French).

The angular distributions of the reaction $^{16}O(d,p_1)^{17*}O$ (871 keV) were analyzed in terms of interference of stripping (DWBA) and compound-nucleus formation near previously reported resonances at $E_d \approx 0.45$, 0.65, and 1 MeV. (tr-auth)

20465 CALCULATED GAMMA TRANSITIONS BETWEEN ^{18}O LEVELS. Shlomo, S.; Moreh, R. (Israel Atomic Energy Commission, Negev). Nucl. Phys., A110: 204-10(1968).

Gamma transitions and branching ratios are calculated for ^{18}O excited levels using different sets of shell-model wave functions having deformed state admixtures reported by Federman-Talmi, by Benson-Irvine and by Federman. The neutron and proton effective charges are allowed to vary and the results are compared with recent experimental measurements on the decay of ^{18}O levels. The results obtained using Benson-Irvine wave functions were found to give better agreement with experiment. (auth)

20466 ^{6}Li INDUCED REACTIONS ON ^{12}C AT E_{lab} = 20 MeV. Meier-Ewert, K.; Bethge, K.; Pfeiffer, K.-O. (Univ. of Heidelberg). Nucl. Phys., A110: 142-60(1968).

Differential cross sections for the reactions $^{12}C(^{6}Li,d)^{16}O$, $^{12}C(^{6}Li,\alpha)^{14}N$ and $^{12}C(^{6}Li,p)^{17}O$, were measured at E_{lab} = 20 MeV. The angular distributions exhibit neither pure direct nor pure compound nuclear reaction mechanisms. It is assumed that the excitation of the $8.88(2^{-})$ MeV level in ^{16}O is due to a pure compound nuclear reaction. To estimate the compound nucleus contribution for some of the low-lying levels in ^{16}O, Hauser-Feshbach calculations were carried out. The strong excitation of some rotational states in ^{16}O can be explained by a good angular momentum match for a direct α-particle capture. A similar explanation fails for the states in ^{14}N. (auth)

20467 THE STRUCTURE OF ^{7}Li AND ^{12}C STUDIES BY INELASTIC SCATTERING OF 185-MeV PROTONS. Johansson, A.; Sundberg, O.; Tibell, G. (Univ. of Uppsala). pp 63-6 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The inelastic scattering of 185-MeV protons from light nuclei (^{6}Li to ^{27}Al) was studied with a resolution of 350 keV (FWHM). Angular distributions are presented for one state in ^{7}Li (0.478 MeV) and for one in ^{12}C (13.9 ± 0.1 MeV). The results are compared with other experiments and with theoretical predictions. (auth)

20468 AN INVESTIGATION OF NEUTRON PICKUP FROM ^{11}B. Dehnhard, D.; Morrison, G. C.; Vager, Z. (Argonne National Lab., Ill.). pp 112-15 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Differential cross sections of the $^{11}B(d,t)^{10}B$ reaction were measured at E_D = 21.6 MeV. Relative spectroscopic factors were compared with those obtained from previous $^{11}B(p,d)^{10}B$ experiments and with predictions of the intermediate-coupling model. Very good agreement was found between the $^{11}B(d,t)$ experiment and theory. (auth).

20469 A METHOD OF DETERMINING THE SPECTROSCOPIC FACTORS FROM (d,p) REACTIONS BELOW THE COULOMB BARRIER. Beaumevieille, Henry; Lambert, Michel; Yaker, Malika; Amokrane, Areski (Institut d'Etudes Nucleaires, Alger, Algeria). pp 121-5 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

A method was devised for determining spectroscopic factors using (d,p) reactions with low Q-values. The method was applied to the reactions $^{14}N(d,p_0)$ and $^{14}N(d,p_7)$, both of which correspond to $l_n = 0$ transitions. (D.C.W.)

20470 NUCLEON TRANSFER REACTION STUDIES IN THE $^{14}N + ^{12}C$ SYSTEM. Birnbaum, J.; Bromley, D. A. (Yale Univ., New Haven). pp 157-61 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

Carbon targets were bombarded with a 148-MeV ^{14}N beam, and the resulting transfer reactions were found to populate selectively those levels in the product nuclei with dominant single-particle configuration. Angular distributions of all resolved levels are smooth, in disagreement with the Frahn-Venter diffraction model but in accord with theories of Dodd and Greider and of Durand. (auth)

20471 THE NUCLEAR MASSES OF ^{9}C AND THE CORRESPONDING ANALOG STATE OF ^{9}B. Barnes, C. A.; Adelberger, E. G.; Hensley, D. C.; MacDonald, A. B. (California Inst. of Tech., Pasadena). pp 261-4 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

The mass excesses of ^{9}C and its analog state in ^{9}B were measured to be (28,916 ± 5) and (27,076 ± 5) keV respectively. From the new value of the ^{9}B ($T = 3/2$) mass, and those of ^{9}Li and ^{9}Be ($T = 3/2$), a predicted ^{9}C mass excess of (28,964 ± 30) keV follows from the quadratic mass formula. It is conjectured that the apparent discrepancy is due to Thomas-Ehrman shifts. (auth)

20472 EXCITATION OF LEVELS IN LIGHT NUCLEI BY INELASTIC ELECTRON SCATTERING. Artus, H.; Brix, P.; Clerc, H.-G.; (and others). (Technische Hochschule, Darmstadt, Ger.). pp 314-18 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

Nuclear levels of ^{6}Li, ^{7}Li, ^{9}Be, ^{11}B, ^{12}C, ^{16}O, ^{24}Mg, ^{28}Si, and ^{40}Ca were studied by inelastic electron scattering at low momentum transfer. Measured energies, type of transitions, ground-state radiation widths, and transition radii are given. A spectrum is shown for the giant resonance region of ^{24}Mg. (auth)

20473 GIANT DIPOLE STATES AND EXCITED GIANT DIPOLE STATES IN ^{12}C. Kamimura, M.; Ikeda, K.; Arima, A. (Tokyo Univ.). pp 332-4 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

The giant dipole resonance and the excited giant dipole resonance, which are observed in the reactions $^{11}B(p,\gamma_0)^{12}C$ and $^{11}B(p,\gamma_1)^{12*}C(2^+)$, are studied. A coupling of the quadrupole vibration with the dipole oscillation is taken into account in the calculations based on the j-j coupling shell model and is found to play an essential role to explain the two reactions. (auth)

20474 DECAY MODES OF ^{16}O GIANT RESONANCE STATES. Owens, R. O.; Baglin, J. E. E. (Yale Univ., New Haven). pp 337-41 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

A Ge(Li) spectrometer was used to observe yields of deexcitation gamma rays following the photodisintegration of ^{16}O at giant resonance energies. The 6.33-MeV ($5/2^-$) ^{15}N state, populated throughout the giant resonance, provides 41 ± 5% of the gamma rays. The 6.16-MeV ($3/2^-$) ^{15}O line and the 5-MeV ($1/2^+$, $5/2^+$) states are populated mainly from excitations of 25 and 23 MeV, respectively, and provide, respectively, 22 ± 5% and 37 ± 5% of the gamma rays. Departure from the single-particle E1 process is inferred. (auth)

20475 ENERGY SPECTRA OF PHOTONEUTRONS AT EXCITATION ENERGIES UP TO 60 MeV. Fink, F. W. K. (Yale Univ., New Haven). pp 352-6 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

The 90° energy spectra of photoneutrons from eight nuclei in the region $12 \leq A \leq 181$ were studied at bremsstrahlung energies of 60 MeV using an electron linear accelerator and nanosecond time-of-flight system. Appreciable yields of high-energy neutrons are observed which correspond to ground state or nearground state transitions; the spectra exhibit a strong A-dependence. (auth)

20476 A STUDY OF THE γ-EMITTING LEVELS IN ^{18}O. Chase, L. F. Jr.; Kohler, D. A.; Becker, J. A.; McDonald, R. E. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). pp 930-3 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

The properties of the levels of ^{18}O below 8 MeV were investigated using the $^{19}F(t,\alpha\gamma)^{18}O$ reaction. Particle-gamma angular correlations were measured using method II of Litherland and Ferguson, and gamma-ray branching ratios were determined. Evidence for a 0^- assignment for the 6.86-MeV level in ^{18}O is presented. (auth)

20477 STUDY OF SOME EFFECTS IN REACTIONS WITH THREE OUTGOING PARTICLES; $d + {}^7Li \rightarrow n + \alpha + \alpha$ AND $p + {}^6Li \rightarrow p + d + \alpha$. Valkovic, V.; Emerson, S. T.; Jackson, W. R.; Phillips, G. C. (Rice Univ., Houston, Tex.). pp 989-93 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

Different processes, their importance and competition, particularly interference and rescattering effects, in the case of reactions with three outgoing particles are discussed. The reaction $d + {}^7Li \rightarrow n + \alpha + \alpha$ has been studied detecting $n - \alpha$ and $\alpha - \alpha$ coincidences simultaneously at deuteron bombarding energies from 2.6 to 4.0 MeV in steps of 0.2 MeV. The reaction $p + {}^6Li \rightarrow p + d + \alpha$ has been studied by detection of all possible two-particle coincidences at 9-MeV bombarding energy and several angles. (auth)

20478 ON THE REACTION $(\pi^+,2p)$ IN ^{6}Li. Charpak, G.; Favier, J.; Massonnet, L.; Zupancic, C. (CERN, Geneva). pp 465-9 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

The reaction $(\pi^+,2p)$ on ^{6}Li leaves ^{4}He either in its ground state or in a broad continuum peaked at around 30 MeV. The ground-state events closely conform to a peripheral description with a probability of $\theta^2 \sim 0.5$ for the configuration $^{4}He_{g.s.} + d$ of ^{6}Li. It also seems possible to reproduce the shape of the peak in the continuum by a direct reaction model without necessarily postulating any particular excited states of ^{4}He. (auth)

20479 ON THE π^- MESON ABSORPTION BY ^{6}Li. Sakamoto, Y. (Kyoto Univ.). pp 474-7 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

The absorption of stopped π^- mesons by a proton-neutron pair in ^{6}Li, accompanied by the emission of the pair, is considered. It is shown that the correlation of the nucleon pair is studied by the absorption rate, given as a function of the recoil momentum of the residual nucleus, or of the center-of-mass momentum of the pair. (auth)

20480 ^{8}He PRODUCTION IN NEGATIVE PION CAPTURE BY CARBON AND OXYGEN NUCLEI. Batusov, Yu. A.; Bunyatov, S. A.; Sidorov, V. M.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 478-81 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

The events of ^{8}He production and decay in negative pion capture by carbon and oxygen nuclei were detected in photoemulsion. The probability of ^{8}He production is 2 to 3×10^{-5}. The mass of ^{8}He was measured to be $M_{^8He} = 7481.3 \pm 0.9$ MeV. (auth)

20481 THEORY OF MUON CAPTURE IN ^{16}O. Morita, M. (Osaka Univ.); Hirooka, M.; Narumi, H. pp 482-3 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (e). New York, Academic Press, 1967.
See CONF-660906.

In the Columbia and Berkeley experiments on muon capture in ^{16}O, the observed transition rates for $0^- \rightarrow 0^+$ are about ten times smaller than those for $2^- \rightarrow 0^+$. This means that there is cancellation among contributions of several matrix elements in the $0^- \rightarrow 0^+$ transition. In such a case, the effect of nuclear finite size becomes important, as is known in the theory of beta decay. A previous formalism of muon capture has been developed to include the exact muon wave functions. Narumi's numerical solutions of muon wave functions adjusted by experimental data of μ-mesic x rays in ^{16}O were adopted. Computations are being performed for various nuclear models. More reliable values of the induced pseudoscalar coupling constant vs axial vector are expected very soon. (auth)

20482 PIONIC AND MUONIC X RAYS FROM LIGHT ELEMENTS. Backenstoss, G.; Charalambus, S.; Daniel, H.; Poelz, G.; Schmitt, H. (CERN, Geneva). pp 484-6 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

Pionic and muonic x rays from ^{10}B, ^{11}B, C, N, O, Na, and Al have been measured with a germanium counter. Data of electromagnetic nuclear radii and pionic 1s level shifts and widths are given. The shifts and widths are in good agreement with Brueckner's theory. Strong cross-over transitions such as n = 4 → n = 1 were observed. (auth)

20483 UNRESTRICTED HARTREE–FOCK CALCULATIONS. Bassichis, W. H.; Kerman, A. K.; Svenne, J. P. (Massachusetts Inst. of Tech., Cambridge). pp 855-8 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Hartree-Fock calculations were carried out for the ground-state binding energy of the even-even nuclei from A = 4 to A = 40. The calculations are unrestricted in the sense that angular as well as radial variations are allowed in the single-particle trial wave functions. The Tabakin and Yale-Shakin forces were used. Parity mixing was also investigated. (auth)

20484 PICKUP REACTION AT 156 MeV AND SPECTROSCOPIC FACTORS IN THE 1p SHELL. Bachelier, D.; Bernas, M.; Brissaud, I.; Detraz, C.; Radvanyi, P. (Institut de Physique Nucleaire, Orsay, France). pp 865-8 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Eight 1p-shell nuclei were studied by the (p,d) reaction at 156 MeV. Spectroscopic factors were extracted in a simple way and were compared with various theoretical predictions. In most cases, they are in agreement within 30% with those calculated from the wave functions of S. Cohen and D. Kurath. For a few levels, higher shell contributions or a more complex mechanism seem necessary. (auth)

20485 F-WAVE LEVELS OF ^{7}Be AND ^{7}Li. Spiger, R. J.; Tombrello, T. A. (California Inst. of Tech., Pasadena). pp 873-8 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The reactions $^{4}He(^{3}He,^{3}He)^{4}He$ and $^{3}H(\alpha,\alpha)^{3}H$ were used to study levels in ^{7}Be and ^{7}Li for excitation energies between 4 and 11 MeV. This work reconfirms the assignments of the $^{2}F_{\frac{5}{2}}$ and $^{2}F_{\frac{7}{2}}$ levels, studies of the properties of the $^{4}P_{\frac{5}{2}}$ levels, and for the first time permits the observation of the $^{4}D_{\frac{5}{2}}$ levels predicted by the intermediate-coupling shell model. (auth)

20486 PROPERTIES OF THE LOWEST T = 3/2 LEVEL IN ^{13}N. Temmer, G. M.; van Bree, R. (Rutgers-The State Univ., New Brunswick, N. J.). pp 880-4 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The lowest T = 3/2 level in ^{13}N was investigated as a compound-nucleus resonance in the isospin-forbidden reaction $^{12}C + p \rightarrow {}^{13}N^{*}$. Using 1-keV steps across the resonance, with 400-eV beam resolution, $\Gamma = (1.9 \pm 0.6)$ keV is obtained, which is consistent with theoretical estimates. Decay to the 4.433-MeV 2^{+} state in ^{12}C also resonates, while the 9.64-MeV 3^{-} level does not. The radiative decays are discussed. (auth)

20487 BINDING ENERGY OF ^{16}O WITH A VELOCITY-DEPENDENT NUCLEON POTENTIAL. McCarthy, R. J.; Kohler, H. S. (Rice Univ., Houston, Tex.). Phys. Rev. Lett., 20: 671-3(Mar. 25, 1968).

The binding energy and single-particle energies were calculated for ^{16}O using reaction matrix theory and meson-theoretical nucleon potential due to Green and Sawada. The binding obtained is 7.2 MeV/nucleon after Coulomb and center-of-mass corrections, in reasonable agreement with the experimental 7.98 MeV/nucleon. (auth)

20488 ANGULAR CORRELATIONS FOR THE REACTION $^{9}Be(^{3}He,\alpha)^{8}Be(16.92) \rightarrow \alpha + \alpha$. Moazed, Cyrus; Holmgren, Harry D. (Univ. of Maryland, College Park). Phys. Rev., 166: 977-87 (Feb. 20, 1968).

Angular correlations for the $^{9}Be(^{3}He,3\alpha)$ reaction proceeding via the 16.92-MeV state of ^{8}Be were obtained by measuring the energies of two α particles in coincidence. The measurements were made by varying the angle of observation of the breakup α particle, a constituent of $^{8}Be(16.92)$, with respect to the angle of emission of the initial α particle fixed at laboratory angles of 0°, 20°, 40°, 60°, 90°, and 140°. These measurements were carried out in the initial reaction plane and in the plane perpendicular to the reaction plane. The observed angular correlations involving the formation of the $^{8}Be(16.92)$ are consistent with the assignment of $J^{\pi} = 2^{+}$ for this state and exclude the possibility of $J^{\pi} = 0^{+}$. The distorted-wave pickup description was used in the analysis of the angular correlations from the reaction $^{9}Be(^{3}He,\alpha)^{8}Be(16.92) \rightarrow 2\alpha$, which was assumed to be a two-step process in which the first step is a direct pickup. (auth)

20489 ANALYSIS OF THE REACTION $^{16}O(t,p)^{18}O$. Kolltveit, Kristofer (Michigan State Univ., East Lansing). Phys. Rev., 166: 1057-63(Feb. 20, 1968).

The reaction $^{16}O(t,p)^{18}O$ is analyzed, assuming contributions to the cross section from the possible core-excited states in the target to be negligible. The shell-model amplitudes and relative phases for the $J = 0^{+}$ and $J = 2^{+}$ states in ^{18}O are calculated. Several solutions are obtained. The overlaps with some shell-model calculations are tabulated. (auth)

20490 SPIN ASSIGNMENTS OF THE ^{12}B 0.95-, 1.67-, AND 2.62-MeV LEVELS. Chase, L. F. Jr. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.); McDonald, R. E.; True, William W.; Warburton, E. K. Phys. Rev., 166: 997-1003 (Feb. 20, 1968). (UCD-CNL-86).

γ-γ angular correlations were performed on the ^{12}B 1.67 → 0.95 → 0 and 2.62 → 0.95 → 0 cascades following formation of the initial states via the $^{11}B(d,p)^{12}B$ reaction. Deuteron energies of 1.70 and 3.13 MeV, respectively, were used. The results, when combined with previous information, lead to spin-parity assignments of 2^{+}, 2^{-}, and 1^{-} for the ^{12}B 0.95-, 1.67-, and 2.62-MeV levels. Some information on the γ-ray decay modes of these states was obtained. This information is in good accord with previously reported work. $^{11}B + d$ yield curves were obtained for the production of 0.95- and 1.67-MeV γ rays and for the coincidence rate between these two γ rays for deuteron energies between 0.55 and 3.05 MeV. Yield curves for production of the ^{12}B 0.95-, 1.67-, and 2.62-MeV levels were constructed from these γ-ray yield curves. (auth)

20491 GAMMA-RAY DECAY OF THE BOUND LEVELS OF ^{12}B. Olness, J. W.; Warburton, E. K. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 166: 1004-11(Feb. 20, 1968). (BNL-11813).

Particle-γ and γ-γ coincidence measurements on the $^{11}B(d,p\gamma)^{12}B$ reaction were performed to determine the decay schemes of the bound excited states of ^{12}B. Branching ratios for the decay of the second excited state (1.67 MeV) to the ground state and first excited state (0.953 MeV) were determined to be (96.8 ± 0.5) and (3.2 ± 0.5)%, respectively. The 2.62-MeV third excited state was found to decay to the ground state with a branch of (6 ± 1)%, and also to the first and second excited states with branches of (80 ± 3) and (14 ± 3)%, respectively. The last two values are from a γ-γ-γ coincidence measurement of the 2.62 → 1.67 → 0.95 → 0 triple cascade. Ge(Li) measurements of the 2.62 → 0.95 transition energy yield a value of 2620.8 ± 1.2 keV for the excitation energy of the initial state. A lower limit on the ground-state decay of the 2.723-MeV level of > 85% was determined from p-γ coincidence measurements. These results are combined with previously available information on lifetimes, spins, and parities to permit a comparison with the shell-model predictions for the electromagnetic transitions connecting the bound levels of ^{12}B. (auth)

20492 LIFETIME OF THE FIRST EXCITED STATE OF ^{15}C. Mendelson, R. A. Jr.; Carpenter, R. T. (Univ. of Iowa, Iowa City). Phys. Rev., 166: 988-91(Feb. 20, 1968).

The lifetime of the first excited state of $^{15}C(0.750$ MeV, $5/2^{+})$ produced in the $^{9}Be(^{7}Li,p)^{15}C$ reaction was measured using the delayed-coincidence technique. A solid-state detector was used to measure the energies of the protons as well as to produce timing signals. The mean lifetime was determined to be $(3.77 \pm 0.11) \times 10^{-9}$ sec. This result is in good agreement with an earlier value of $(3.73 \pm 0.23) \times 10^{-9}$ sec obtained using a pulsed-beam method. Disagreement with weak-coupling collective-model predictions based on neighboring $2s_{\frac{1}{2}} \rightarrow 1d_{\frac{5}{2}}$ transitions is thus not removed. (auth)

20493 EFFECTS OF A SOFT-CORE POTENTIAL ON THE ABSORPTION OF STOPPED π^{-} MESONS. Cheon, Il-Tong (Kyoto Univ. Kobe-Gakuin Coll., Japan). Phys. Rev., 166: 1051-6(Feb. 20, 1968).

Making use of the correlation function determined on the basis of the Brueckner theory, total absorption rates, the effects of the short-range N-N correlations on the branching ratio W(pn → nn)/W(pp → pn), and the distribution of the absorption rate with respect to the opening angle between the emitted nucleons in negative-pion absorption by ^{12}C nuclei are calculated. Although R^{theor} (pp; 180°/90°) is about ten times as small as the experimental value, other theoretical results are in excellent agreement with the experimental results. (auth)

20494 $^{15}N(p,t)^{13}N$ AND $^{15}N(p,^{3}He)^{13}C$ REACTIONS AND THE SPECTROSCOPY OF LEVELS IN MASS 13. Fleming, Donald G.;

Cerny, Joseph; Maples, Creve C.; Glendenning, Norman K. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 166: 1012-27(Feb. 20, 1968). (UCRL-17840).

A 43.7-MeV proton beam was used to induce (p,t) and (p,^{3}He) reactions on a ^{15}N target. Transitions to mirror final states of ^{13}N and ^{13}C were investigated over 15 MeV of excitation and several new spin and parity assignments were made. The distorted-wave Born-approximation (DWBA) predictions of angular distributions for these ^{15}N(p,t)^{13}N and ^{15}N(p,^{3}He)^{13}C reactions, using intermediate-coupling wave functions to obtain the two-nucleon structure factors, were generally found to reproduce experiment well; in addition, calculated cross sections for the ^{15}N(p,t)^{13}N reaction were in good agreement with the experimental values. (auth)

20495 MASS-SPECTROMETRIC MEASUREMENT OF LITHIUM, BERYLLIUM, AND BORON ISOTOPES PRODUCED BY ^{16}O BY HIGH-ENERGY PROTONS, AND SOME ASTROPHYSICAL IMPLICATIONS. Yiou, F.; Baril, M.; Dufaure de Citres, J.; Fontes, P.; Gradsztajn, E.; Bernas, R. (Centre National de la Recherche Scientifique, Orsay, France). Phys. Rev., 166: 968-74(Feb. 20, 1968).

A special mass-spectrometric method has been developed to determine the isotopic ratios and isotopic absolute cross sections of Li, Be, and B, formed by spallation of oxygen irradiated by protons of energy 135, 550, and 19 GeV. A brief description is given of the ion source of the mass spectrometer—of an ion sputtering type—which permits a very efficient ionization of beryllium and boron. The performances are given; they allow the analysis of 10^{-12} to 10^{-13} g of these elements. The oxygen target is made of very high purity water, and special handling techniques have been worked out to reduce contamination to an acceptable level. The determination of each of the isotopic ratios ^{7}Li/^{6}Li, ^{9}Be/^{7}Be, ^{10}Be/^{9}Be, and ^{11}B/^{10}B requires a specific method, which is described. Isotope dilution techniques are used to obtain the absolute cross sections; values in millibarns for 135-MeV protons are as follows: ^{6}Li: 10 ± 2, ^{7}Li: 8.0 ± 2.5, ^{9}Be: 1.7 ± 0.5, ^{10}Be: 0.35 ± 0.20, ^{10}B: 11 ± 3, and ^{11}B: 25 ± 8. There are no significant changes at the higher energies. The above cross sections give support to conclusions based previously on calculated values concerning the spallation origin of Li, Be, and B in the solar system, in stars, and in the cosmic radiation. (auth)

20496 LOW-ENERGY π-NUCLEUS ELASTIC SCATTERING ANALYSIS. Beiner, Jean; Huguenin, Pierre (Univ., Neuchatel, Switzerland). Z. Angew. Math. Phys., 18: 912-15(Nov. 25, 1967).

The optical analysis of π^-–carbon scattering using the primitive Kisslinger equation was repeated to compare results with those of Ericson and Ericson. Potentials were calculated by the χ^2 method for energies of 87.5, 80.0, and 69.5 MeV. Phase shifts were also calculated for 80.0 MeV. The complex function Z_0 was calculated from the pi-mesic atom and from the scattering; the approximation vanishes at ~110 MeV, indicating a broad resonance in s state. (D.L.C.)

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Refer also to abstracts 19138, 20113, 20127, 20129, 20370, 20472, 20475, 20482, 20576, 20578, 20597, 20640, 20668, 20681, 20682, 20686, 20688, 20689, 20702, 20713, 20727, and 20728.

20497 (AECL-3009) PHYSICS DIVISION PROGRESS REPORT, OCTOBER 1, 1967–DECEMBER 31, 1967. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 81p. (PR-P-76). Dep. CFSTI. CAN.

Another attempt was made to observe the gamma decay of the 8^+ member of the ground-state rotational band in ^{20}Ne by searching for a resonance in the ^{4}He(^{16}O,γ)^{20}Ne reaction using the differentially pumped gas target. No peak was observed above the background of gamma rays produced by inelastic scattering; an upper limit of 0.5 was established for the enhancement of the $8^+ \rightarrow 6^+$ transition relative to the $6^+ \rightarrow 4^+$ transition. The ratio of the calculated enhancements is 0.59 on the basis of the SU_3 model, and 1.05 from the simple rotational model. The Lotus augular-correlation array was used, with six NaI(Tl) detectors and one 40 cm^3 Ge(Li) detector, to determine the spins of eight levels between 3.9 and 5.3 MeV excitation in ^{26}Mg; three definite and five probable spin values were obtained. The spins of two levels in ^{27}Al were also determined. Experiments were also started on the multiple Coulomb excitation, by 90-MeV ^{35}Cl ions, of levels in gadolinium and dysprosium isotopes. The $\pi\sqrt{2}$ beta spectrometer was used to study the conversion electron spectra of low-energy transitions in ^{171}Tm following ^{171}Er decay. Gamma-gamma coincidence experiments were carried out on the decay of ^{153}Gd. An experiment is being started to use the double flat-crystal spectrometer to measure very precisely the positron-annihilation gamma-ray energy, which will provide a more accurate value of the fine structure constant than is presently available. A prototype of the angle-measuring part of the spectrometer was constructed using an optical interferometer provided with electro-mechanical feedback to ensure mechanical stability. Preliminary tests indicate a stability equivalent to ±0.001 seconds of arc, corresponding to a precision of $1:10^6$ in the gamma-ray wavelength measurements. The Radioisotope Standardization Group has measured the 2200 m/s neutron capture cross section of ^{59}Co as 37.1 b, relative to 98.7 b for ^{197}Au. The cobalt content of the Al-1% Co alloy wire used as a flux monitor at CRNL has been measured to be (1.012 ± 0.004) wt %. This redetermination, and the remeasurement of the ^{59}Co cross section, necessitate a correction of about 3% to the value previously obtained for deuterium capture cross section (Nucl. Sci. Eng., 28: 286 (1967)). The normal mode frequencies of the organic molecular crystal deuterated hexamethylenetetramine (DHMT) are being measured. Preliminary, low-resolution measurements were made in the Λ(F) direction, and more detailed, high-resolution observations were made in the Δ direction, using the triple-axis spectrometer at the C5 facility, NRU. The results are in fair agreement with the model proposed by Cochran and Pauley (Proc. Roy. Soc., A 280: 1 (1964)) for hydrogenous hexamethylenetetramine adjusted to take account of the mass and moment of inertia of DHMT, and model parameters were obtained by fitting to the present results. Measurements at helium temperatures of the neutron inelastic scattering from a single crystal of manganese fluoride doped with about 5% cobalt revealed a local magnetic mode at 3.57 (10^{12} cps) and a spin-wave band between 0.3 and 1.61. The reduction in frequency and the broadening of the local and spin-wave modes have now been measured at 23.3°K, 34.8°K, 51°K, 56.5°K, and 60°K. The behavior of the spin-waves in the [001] direction followed that observed in pure MnF_2 by Turberfield et al.; the frequency of the local mode fell less rapidly than the band modes as the temperature was increased. The value of the local mode frequency at 4.5°K is consistent with an Ising model having interactions with nearest neighbours in the ⟨111⟩ directions, but the temperature dependence is not. The temperature dependence suggests that the magnetization of the near neighbours, rather than following the host magnetization, is enhanced at high temperatures by the presence of the impurity. A self-consistent molecular field calculation, made for a cluster consisting of the impurity ion and up to sixth-neighbour host ions, shows that the magnetization on the Mn^{2+} ions round a Co^{2+} ion is greater at high temperatures than that of the host ions at large distances; a typical enhancement is 13% at 56.5°K. The local mode frequency was then calculated from this enhancement and the effective host magnetization as given by the spin-wave frequency in pure MnF_2. The results are in excellent agreement (3% at 56.5°K) with the measured local mode frequency. Previous measurements of neutron inelastic scattering from liquid helium, using the rotating crystal spectrometer, were obtained at values of Q (momentum transfer/ħ) up to 5.6 Å^{-1}. Measurements with the C5 triple axis spectrometer have been extended to Q = 9 Å^{-1}. The scattered neutron distribution at each value of Q consists of a broad peak whose mean energy, E, is consistent with scattering from a gas of free helium atoms, i.e. $E = \hbar^2Q^2/2\underline{M}$, where $\underline{M}$ is the mass of the helium atom. A plot of the width of the distributions as a function of Q exhibits several plateaux with steep rises between them. A straight line through these results, however, passes through the origin and has a slope consistent with theoretical predictions for liquid helium. The relative average energy per electron-hole pair was measured in four Ge(Li) detectors. Its change over the temperature range 25 to 170°K was between 1.0 and 2.2% for the four detectors, a much smaller variation than that reported by Emery and Rabson (Phys. Rev., 140: A 2089 (1965)). The technique of using a finely collimated beam of gamma rays to study the behavior of Ge(Li) detectors is proving to be generally very valuable. It is currently being used to investigate the effects of warm-up and re-drift cycles, trapping effects, and the origin of slow pulses. The ridge which develops on the fuel sheath at the interface between dished fuel pellets is well known. This problem was investigated by treating the pellet as a uniform rod with plane ends subject to a narrow ring of pressure on each end. The calculated behavior agrees qualitatively with experimental observations. But a quantitive comparison requires a knowledge of the compressive stress-strain curve for UO_2 beyond the yield point and at temperatures in the range 400 to 600°C, and these data are not available. Agreement is obtained by taking a reduced Young's modulus equal to one sixtieth of the value for the proportional part of the curve at room temperature. In order to meet the varied requirements of a number of different groups using multi-channel analyzers a flexible spectrum analysis program is being developed. Lines are fitted by an expression that can allow

for the asymmetry often observed with solid-state detectors. (auth)

20498 (BNL-12268) GAMMA RAYS FOLLOWING NEUTRON CAPTURE IN IRON, SODIUM, AND THORIUM. Wasson, O. A.; Garg, J. B.; Chrien, R. E.; Bhat, M. R. (Brookhaven National Lab., Upton, N. Y.). Mar. 4, 1968. 17p. (CONF-680307-12). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

The intensities of prominent γ rays from neutron capture in iron, sodium, and thorium were measured as a function of incident neutron energy at the HFBR fast chopper facility at Brookhaven. The partial capture cross section of 27 γ rays in iron was measured from thermal to 5-keV neutron energies. Additional γ rays were observed in the 1167-eV resonance and at thermal energy. In sodium, the observation of a ground-state γ ray in the thermal spectrum (E_γ = 6960 ± 2.0 keV) with an intensity of ~0.1 photons/100 captures supports the 2^+ assignment of the 2.85-keV resonance. The γ-ray spectra from capture at thermal and in the four lowest energy S-wave resonances in ^{232}Th exhibit large fluctuations in the partial radiation widths. (auth)

20499 (INP-577/PL) ZJAWISKA REZONANSOWE W SPREZYSTYM ROZPRASZANIU CZASTEK ALFA NA JADRACH ATOMOWYCH. (Resonance Phenomena in the Elastic Scattering of Alpha Particles on Atomic Nuclei). Jarczyk, Lucjan (Institute of Nuclear Physics, Krakow (Poland)). Sept. 1967. 37p. (In Polish). Dep.

A report of resonance phenomena in the elastic scattering of alpha particles on atomic nuclei is given. The experimental angular distributions of the differential cross section for the elastic scattering of alpha particles on ^{39}K and ^{40}Ca nuclei in the energy range from 22 to 29 MeV were analyzed by means of the optical model. No satisfactory fits between the calculated and experimental results were obtained. The agreement could be considerably improved by modifying the phase shifts for the l = 10 partial waves. The resonances in the excitation curves indicate the possibility of the creation of highly excited single-particle states with cluster structure in ^{43}Sc and ^{44}Ti nuclei. (auth)

20500 (JINR-P6-3698) γ-IZLUCHENIE ^{69}Ge. (γ-Radiation of ^{69}Ge). Vrzal, Ya.; Dzhelepov, B. S.; Liptak, Ya.; Moskvin, L. N.; Prikhodtseva, V. P.; Sidorova, T. I.; Urbanets, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 12p. (In Russian). Dep.

The γ-ray spectrum from the decay of ^{69}Ge was measured using the Ge(Li) detector with a volume of about 12 cm^3. The energies and the intensities of γ transitions as well as the values of log ft were determined. The more complete decay scheme is constructed. (auth)

20501 (SGAE-PH-61/1967) THE REACTOR NEUTRON CAPTURE CROSS SECTION OF ^{46}Sc AND A DETERMINATION OF THE BETA BRANCHING RATIO OF THE ^{47}Sc DECAY. Bak, Zong-Tschun; Riehs, P. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physik-Institut). [1967]. 10p. Dep.

The secondary neutron capture cross section for the thermal neutron flux monitor Sc is determined as 7.7 ± 0.6 b by activity measurements. By means of a 4π β-γ coincidence measurements, the relative intensity of the 160-keV gamma ray of ^{47}Sc was found to be 0.68 ± 0.027 per decay. (auth)

20502 GAMMA TRANSITIONS AND ENERGY LEVELS IN ^{49}V FROM THE REACTION ^{48}Ti(p,γ)^{49}V. Klapdor, H. V.; Zausig, B. (Univ., Hamburg). Z. Phys., 210: 457-65(1968). (In German).

Deexcitation gamma rays of ^{49}V from the ^{48}Ti(p,γ)^{49}V reaction were investigated at the resonances E_p = 1007, 1209, 1362, and 1374 keV corresponding to excited states in ^{49}V at 7742, 7940, 8090, and 8102 keV. A 4 cm^2 × 0.35 cm lithium-drifted germanium detector was used. The target was TiO_2 enriched in ^{49}Ti to 99.4%. 71 gamma transitions were observed. A level scheme of ^{49}V is proposed involving 8 new levels in the energy range from 0 to 5.2-MeV excitation energy. (auth)

20503 SCATTERING OF PROTONS NEAR THRESHOLDS OF (p,n) REACTIONS TO ANALOGUE STATES. Friedman, E.; Ginzburg, A.; Jaffe, A. A.; Marinov, A. (Hebrew Univ., Jerusalem). Nucl. Phys., A110: 300-04(1968).

The excitation functions for the elastic and inelastic proton scattering on targets of ^{55}Mn, ^{56}Fe, ^{63}Cu, and ^{65}Cu were measured at several angles. A search for effects of coupling between the proton and neutron channels for incident proton energies near the thresholds of the (p,n) reaction leading to analog states yielded negative results. (auth)

20504 SOME BRANCHING RATIOS IN ^{26}Mg. Daniels, T.; Calvert, J. M.; Adams, A. (Manchester Univ., Eng.). Nucl. Phys., A110: 339-52(1968).

The decay modes of levels at 3.943, 4.350, and 4.830 MeV in ^{26}Mg are established and those of levels at 1.805 and 2.941 MeV are confirmed using the ^{25}Mg(d,pγ)^{26}Mg reaction. The protons were detected at 0° and the gamma rays observed in coincidence with selected proton groups. Relative l = 0 spectroscopic factors are also extracted and compared with existing measurements. Gamma rays from the ^{22}Ne(α,p)^{25}Mg reaction were also observed using Ge(Li) detectors enabling the branching ratios of levels at 3.584, 4.319, 4.331 and 4.896 MeV to be estimated. (auth)

20505 THE (d,^{3}He) REACTION ON THE N = 28 NUCLEI AT 34 MeV. Newman, E. (Oak Ridge National Lab., Oak Ridge, Tenn.); Hiebert, J. C. Nucl. Phys., A110: 366-78(1968).

Deuterons accelerated at 34.4 MeV were used to investigate the (d,^{3}He) reaction on ^{49}Ti and on the N = 28 nuclei ^{48}Ca, ^{50}Ti, ^{51}V, ^{52}Cr, and ^{54}Fe. The angular distributions were compared with local zero-range DW calculations from which the transferred angular momenta and spectroscopic factors were deduced. The results are consistent with the simple model considering $f_{\frac{7}{2}}$ protons outside an inert ^{48}Ca core. Small deviations from this description are found for ^{54}Fe where evidence for both $f_{\frac{7}{2}}$ and $p_{\frac{3}{2}}$ admixtures are noted in the ground state. For the N = 28 nuclei it was found that the $1d_{\frac{3}{2}}$ proton shell is more tightly bound than the $2s_{\frac{1}{2}}$ proton shell. (auth)

20506 EVEN-PARITY STATES OF ^{43}Sc. Johnstone, I. P. (Oxford Univ.). Nucl. Phys., A110: 429-40(1968).

Restricted Hartree-Fock orbitals are determined for four-particle-one-hole (4p1h) states in ^{43}Sc, and the model Hamiltonian is diagonalized within the subspace of states obtained by angular momentum projection from the lowest $k^\pi = 3/2^+$ and $1/2^+$ configurations. It is found that to account for the observed even-parity spectrum in terms of 4p1h states, it is necessary to use a value for the $d_{\frac{3}{2}}s_{\frac{1}{2}}$ single-hole gap which is less than half the value deduced from the ^{39}K or ^{39}Ca spectra. The main features of electromagnetic transition data are then quite well reproduced. (auth)

20507 (γ,2n), (γ,αn), AND (γ,α2n) REACTIONS ON ^{63}Cu AND THE DECAY OF ^{58}Co. Ritter, J. C.; Larson, R. E.; Hoover, J. I. (Naval Research Lab., Washington, D. C.). Nucl. Phys., A110: 463-71(1968).

The photonuclear yield of the ^{63}Cu(γ,αn)^{58}Co and the ^{63}Cu(γ,α2n)^{57}Co reactions relative to the yield of the ^{63}Cu(γ,2n)^{61}Cu reaction has been measured with thick target bremsstrahlung at end-point energies of 30, 40, and 50 MeV. The ^{57}Co and ^{58}Co were identified by carrier chemistry separation and by gamma-ray energy and half-life measurements. The possibility of competing reactions which could also produce ^{57}Co or ^{58}Co is discussed. The energy and relative intensity of the gamma rays emitted in the decay of ^{58}Co were measured as 811.07 ± 0.2 keV (1000), 863.83 ± 0.5 keV (8.1 ± 0.3) and 1673.1 ± 2 keV (5.7 ± 0.3). The branching ratio obtained for the 1674.8 keV state in ^{58}Fe is (58.7 ± 1.6) % for the $2^+ \rightarrow 2^+$ transition. The results are compared with previous measurements for the decay of ^{58}Co. (auth)

20508 EFFECTS OF CARBON IMPURITIES ON THE INTENSITY RATIOS OF THE MOESSBAUER SPECTRUM OF METALLIC IRON. Shechter, Hanan (Univ. of Washington, Seattle); Ron, Moshe. Nucl. Phys., A109: 588-92(1968).

Moessbauer measurements on metallic iron of commercial type (enriched by ^{57}Fe or natural, in the form of foils and powders), show in many cases unexpected intensity ratios of the Moessbauer peaks. Carbon impurities were found to be responsible for the incorrect ratios when precipitated in the form of carbides. Proper tempering processes show the stages of precipitation of the carbon in the metallic iron from no precipitates to the stage where all the carbon is precipitated. Measurements at a temperature above the T_c of the carbides show a hyperfine structure of a metallic iron with the expected ratios when corrected for sample thickness. (auth)

20509 ELASTIC SCATTERING OF POLARIZED DEUTERONS FROM ^{27}Al, Si, AND ^{60}Ni BETWEEN 7 AND 11 MeV. Schwandt, P.; Haeberli, W. (Univ. of Wisconsin, Madison). Contract AT(11-1)-Gen-7. Nucl. Phys., A110: 585-608(1968). (COO-7-0446).

Polarization parameters were determined for deuteron elastic scattering from ^{27}Al, Si, and ^{60}Ni at energies between 7 and 11 MeV and laboratory scattering angles from 30 to 135°. The vector polarization, iT_{11}, and two tensor parameters, T_{20} and T_{22}, were measured by scattering polarized and unpolarized deuterons which were obtained from a tandem accelerator. The largest polarization was $|iT_{11}| \approx 0.3$ and $|T_{20}| \approx 0.2$ for ^{27}Al at 11 MeV. For ^{60}Ni, the observed polarizations were substantially smaller. Angular distributions of the unpolarized cross section were also measured for ^{27}Al and Si. An optical-model analysis of the polarization and cross-

section data was performed. The vector polarization was reproduced reasonably well by a vector spin-orbit coupling of similar strength as found for nucleon scattering. A tensor interaction appears to be needed to account for the observed tensor polarizations. (auth)

20510 LIFETIME MEASUREMENTS IN ^{27}Al. Smulders, P. J. M.; Broude, C.; Sharpey-Schafer, J. F. (Chalk River Nuclear Labs., Ontario). Can. J. Phys., 46: 261-7(Feb. 15, 1968). (AECL-3013).

The Doppler-shift attenuation method was used to obtain lifetime estimates of ^{27}Al levels up to 4.6 MeV. Gamma rays following inelastic scattering of protons at E_p = 4.5 and 6.0 MeV were detected in a 40-cm^3 Ge(Li) detector surrounded by a shielded split annulus NaI(Tl) detector. The mean lives of the indicated states were determined as: 1014 keV, 1.5 ± 0.4 ps; 2211 keV, 55 ± 9 fs; 2734 keV, 16 ± 7 fs; 2980 keV, 14 ± 6 fs; 3003 keV, 83 ± 7 fs; 3678 keV, <30 fs; 3955 keV, <20 fs; 4054 keV, <20 fs; 4408 keV, <22 fs; 4509 keV, 300 ± 30 fs; 4580 keV, <30 fs. Branching ratios for these states are reported. The lifetime and decay mode of the 4509-keV level, which decays to the $^7/_2^+$ 2211-keV state and the $^9/_2^+$ 3003-keV state, indicate that this state is possibly the $^{11}/_2^+$ member of the ground-state rotational band. The lifetime of the 3003-keV state is inconsistent with a recent assignment of spin-parity $^7/_2^+$ to this level. (auth) (Canada)

20511 14.8-MeV NEUTRON ACTIVATION CROSS SECTIONS OF ARGON, Husain, L.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem., 30: 355-9(Feb. 1968).

The 14.8-MeV neutron activation cross sections for the reactions ^{38}Ar(n,p)^{38}Cl, ^{40}Ar(n,p)^{40}Cl, ^{40}Ar(n,np)^{39}Cl, and ^{40}Ar(n,α)^{37}S were measured to be 110 ± 22 mb, 15 ± 2 mb, 1.7 ± 0.2 mb, and 10 ± 1.5 mb, respectively. The data are in reasonably good agreement with the theoretically calculated values of Gardner. (auth) (UK)

20512 A REDETERMINATION OF THE HALF-LIFE OF ^{47}Sc. Meadows, J. W. T.; Mode, V. Alan (Univ. of California, Livermore). J. Inorg. Nucl. Chem., 30: 361-3(Feb. 1968). (UCRL-7037(Rev.1)).

Samples of ^{47}Sc of high isotopic purity were prepared. The beta and gamma decay were followed for periods of seven to seventeen half-lives. The half-life was determined to be 3.345 ± 0.003 days. (auth) (UK)

20513 EMISSION OF ^{8}Be IN $\bar{p}$-NUCLEUS INTERACTIONS AT 5 GeV/c. Daetwyler, J. J. (Univ., Bern); Czapek, G.; Jeannet, E. Helv. Phys. Acta, 41: 251-6(Apr. 1, 1968). (In French).

Fifty-two ^{8}Be$_4$ fragments were identified in 6850 stars produced by 5-GeV/c antiprotons in photographic emulsions. The cross section for the emission of ^{8}Be$_4$ from nuclei is found to be 6.3 ± 0.9 mb. The analysis of energy and angular distributions confirm the hypothesis that ^{8}Be$_4$ is emitted before the evaporation process. (auth)

20514 NEW ENERGY LEVELS IN ^{47}V. Albinsson, H.; Dubois, J. (Chalmers Univ. of Tech., Gothenburg, Sweden). Ark. Fys., 34: 1-18(1967).

Gamma spectra were studied at eight resonances in the ^{46}Ti(p,γ)^{47}V reaction. Ten new bound levels were observed; a decay scheme of ^{47}V is proposed. The Q-value was determined to be 5177 + 5 keV. (auth) (Sweden)

20515 LEVEL SCHEMES OF ^{26}Si, ^{30}S, ^{34}Ar, AND ^{42}Ti STUDIED WITH THE (^{3}He,n) REACTION. Hagen, M.; Maier, K. H.; Michaelsen, R. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Phys. Lett., 26B: 432-4(Mar. 4, 1968).

The level schemes of ^{26}Si, ^{30}S, ^{34}Ar, and ^{42}Ti were studied with the (^{3}He,n) reaction at ^{3}He energies between 4.5 and 6.2 MeV using a neutron time-of-flight spectrometer. Reaction energies and excitation energies are given and the latter are compared with those of the isobaric nuclei. (auth)

20516 STUDY OF THE EXCITED LEVELS OF ^{32}S OBTAINED BY THE REACTIONS ^{31}P(p,α$_0$) AND ^{31}P(p,p). Guernet, G.; Ligeon, E.; Longequeue, N.; Chan, Tsan Ung; Longequeue, J. P. (Univ., Grenoble, France. CEN, Grenoble, France). J. Phys. (Paris), 29: 9-14(Jan. 1968). (In French).

The reaction ^{31}P(p,α) was studied in the energy range E_p = 1 to 2 MeV. The elastic scattering was also studied at about 2 MeV. Characteristics of ^{32}S levels were determined between 9.8 and 10.8 MeV. (auth)

20517 THE ^{22}Na POSITRON SPECTRUM. Wenninger, H.; Stiewe, J.; Leutz, H. (Univ., Heidelberg). Nucl. Phys., A109: 561-76(1968).

The ^{22}Na positron spectrum was measured with three ^{22}NaI(Tl) spectrometers working in coincidence with the 2298 keV γ-summing peak of ^{22}Na and with a short-lens magnetic spectrometer in which the β^+ momenta were modified by electrostatic acceleration of the positrons. In contradiction to Langer and coworkers, a purely statistical shape at least down to 60 keV positron energy was found. The Fierz term is nonexistent within b = (+0.8 ± 2.8) × 10^{-3} m_0c^2. As compared with the recently published electron capture to positron emission ratio of ^{22}Na, the results presented here yield strong evidence for orbital electron exchange during the ^{22}Na electron capture process. (auth)

20518 LIFETIME OF THE 3.163 MeV LEVEL OF ^{35}Cl. Azuma, R. E.; Anyas-Weiss, N.; Charlesworth, A. M. (Univ. of Toronto). Nucl. Phys., A109: 577-87(1968).

Delayed coincidence techniques with NaI(Tl) detectors and attenuated Doppler shift methods with a Ge(Li) detector were used to measure the mean life of the 3.163 MeV level of ^{35}Cl. The absence of an observable Doppler shift of the radiation de-exciting the 3.163 MeV level allows the assignment $\tau_\gamma \geq 0.6$ ps as a lower limit for the level lifetime, while the delayed coincidence results give $\tau_\gamma = 0.14 \pm 0.04$ ns. The partial transition probabilities for the mixed M2-E3 decay of this level to the ground state are $|M(M2)|^2 = (8.5 \pm 3.0) \times 10^{-2}$ W.u. and $|M(E3)|^2 = 1.3 \pm 0.6$ W.u. (auth)

20519 LEVEL STRUCTURE OF ^{52}Mn. Rapaport, J.; Dorenbusch, W. E.; Belote, T. A. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys., A109: 657-65 (1968).

The level structure of ^{52}Mn was investigated by the ^{50}Cr(^{3}He,p)^{52}Mn and ^{54}Fe(d,α)^{52}Mn two-nucleon transfer reactions. A total of 29 levels was excited by the (d,α) reaction up to 3.9 MeV. For the (^{3}He,p) reaction, angular distributions of eight levels below 5.5 MeV were measured. A ground-state Q-value of 5.159 ± 0.015 MeV was determined for the (d,α) reaction. The isobaric analogue of the ^{52}Cr ground state was identified as the E_x = 2.95 MeV level, thus yielding a Coulomb displacement energy of ΔE_C = 8.436 ± 0.025 MeV. The level structure of ^{52}Mn is discussed, and the results are compared with the calculated level scheme. (auth)

20520 EXCITATION OF ^{56}Co BY TWO-PARTICLE TRANSFER REACTIONS. Belote, T. A.; Dorenbusch, W. E.; Rapaport, J. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys., A109: 666-75(1968). (MIT-2098-391).

The reactions ^{54}Fe(^{3}He,p)^{56}Co and ^{58}Ni(d,α)^{56}Co were investigated at energies of 12.0 and 7.0 MeV, respectively. Ground-state Q-values of 7.408 ± 0.015 MeV for the (^{3}He,p) and 6.506 ± 0.010 MeV for the (d,α) reactions were measured. Angular distributions for eight of the (^{3}He,p) transitions were measured and analyzed using the DWBA in order to extract L-values. The level scheme of ^{56}Co is discussed in terms of these results. The analog of the ^{56}Fe ground state was identified, and a reduced Coulomb energy ΔE_C = 8.949 ± 0.025 MeV was extracted. (auth)

20521 LEVEL STRUCTURE OF ^{48}V. Dorenbusch, W. E.; Belote, T. A.; Rapaport, J. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys., A109: 649-56 (1968).

Energy levels in ^{48}V up to 3.7 MeV of excitation were identified from the reactions ^{46}Ti(^{3}He,p)^{48}V and ^{50}Cr(d,α)^{48}V. Reaction particles were momentum analyzed in the MIT multiple-gap spectrograph. The Q-value for the (d,α) reaction was found to be 6.923 ± 0.015 MeV. The stronger (^{3}He,p) transitions were analyzed to obtain values of the transferred angular momentum. The results are discussed in terms of $1f_{\frac{7}{2}}$ shell-model calculations. The transition to the ^{48}Ti ground-state analog was observed, and the ^{48}V–^{48}Ti Coulomb energy difference was found to be ΔE_C = 7.813 ± 0.025 MeV. (auth)

20522 J-DEPENDENCE IN l = 3 (d,p) TRANSITIONS. Denning, A. (Univ. of Bradford, Eng.); MacGregor, A. E.; Ball, A. E.; Brown, G.; Glover, R. N. Phys. Lett., 26B: 437-9(Mar. 4, 1968).

J-dependence features of the angular distributions for strong l_n = 3 transitions in (d,p) reactions are reported. Previous criteria for spin assignments are found to be inadequate, and one based on forward angle differences is suggested. (auth)

20523 TOTAL NEUTRON CROSS SECTIONS OF SULFUR AND TUNGSTEN BETWEEN 5.3 AND 6.3 MeV. Kao, Wen Hua; Lin, Shih Chien; Lin, Chang Sung; Lee, Tzong-jen; Tang, Ming Dou; Ma, Peter P. Y.; Lee, Yu Hao; Chien, Ji-peng (National Tsing Hua Univ., Hsinchu, Taiwan). Chin. J. Phys. (Taiwan), 5: 43-54(Oct, 1967).

The total cross sections of sulfur and tungsten were measured for neutron energies of 5.36 to 6.28 MeV by the time-of-flight technique. These values were approximated by the sum of the reaction cross sections and the potential scattering cross sections, the latter of which were calculated. It is thus concluded that the

compound elastic scattering process is insignificant for both the light sulfur nucleus and the heavy tungsten nucleus in this energy range. (auth)

20524 PARTIAL PROTON WIDTHS OF ISOBARIC ANALOGUE STATES IN ^{35}Ar. Bosnjakovic, B.; Bruynesteyn, W. (Rijksuniversiteit, Utrecht). Nucl. Phys., A110: 233-7(1968).

Isobaric analog states of the three lowest levels in ^{35}Cl were studied with the reaction ^{37}Cl(p,p)^{37}Cl. Proton widths were determined of the resonances at E_p = 1138, 1142 and 1732 keV. (auth)

20525 HIGH-RESOLUTION INVESTIGATION OF THE REACTION ^{31}Cl(p,α_0)^{32}S. Bosnjakovic, B.; Bouwmeester, J.; Van Best, J. A.; Pruys, H. S. (Rijksuniversiteit, Utrecht). Nucl. Phys., A110: 17-40(1968).

The ^{31}Cl(p,α_0)^{32}S reaction is investigated in the energy region E_p = 830 to 2930 keV; 76 resonances are observed. Resonance energies, strengths and widths are reported. The analysis of α_0 angular distributions, measured at 58 resonances, allows unique spin and parity assignments in 24 cases. In most other cases, two or three J^π assignments remain possible. Formation and population parameters are determined. Resonances showing significant f-wave proton capture are discussed as possible isobaric analogues of corresponding states in ^{35}Cl. (auth)

20526 ELECTRON-GAMMA DIRECTIONAL CORRELATION EXPERIMENTS IN ^{75}As. Vignau, H.; Mocoroa, A.; Othaz, R.; Baade, N. (Univ. of La Plata). Nucl. Phys., A110: 56-64(1968).

Using an electron-gamma directional correlation spectrometer, the mixing ratios of the 280 keV and 265 keV transitions have been measured. The experimental results are $\delta_{280} = -0.250^{+0.008}_{-0.008}$ and $\delta_{265} = -0.044^{+0.011}_{-0.011}$. The multipolarities of these transitions and the K-conversion coefficient of the 280 keV transition deduced from this information are given. For the 136 keV transition, the L-shell particle parameter was measured. The result $b_{\frac{1}{2}}(E1) = -1.609 \pm 0.252$ is in agreement with the theoretical value. (auth)

20527 STUDY OF STATES IN ^{25}Al AND ^{26}Al BY THE ^{24}Mg(d,n) AND ^{25}Mg(d,n) REACTIONS. Fuchs, H.; Grabisch, K.; Kraaz, P.; Roeschert, G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys., A110: 65-80(1968).

Neutrons from the 5.5 or 6 MeV deuteron bombardment of ^{24}Mg and ^{25}Mg, respectively, were investigated by the time-of-flight method. Angular distributions of (d,n) transitions to eight states in ^{25}Al up to 3.08 MeV and to 38 states in ^{26}Al up to 6.1 MeV excitation energy are obtained. The stronger transitions, altogether 33, have been analyzed with DWBA theory to yield l-values and spectroscopic factors. The observed l-values of the ^{25}Mg(d,n) transitions determine the spin of the ^{26}Al states at 2.66, 5.13 and 5.49 MeV to 2 or 3, their parity as positive and the parity of the levels at 4.699, 4.766 and 5.24 MeV also as positive. Negative-parity states appear at 5.39, 5.45 MeV, around 5.7 MeV and at 5.91 MeV. From comparison with ^{25}Mg(d,p)^{26}Mg, isospin T = 1 is proposed for the levels at 5.13 and 5.24 MeV, and spins I = 2 and I = (2,3), respectively. The experimental spectroscopic factors are compared to predictions of the Nilsson model for ^{25}Al and ^{26}Al. No substantial agreement is obtained for ^{26}Al, whereas the ^{25}Al results are compatible with the theory. A comparison of spectroscopic factors from the ^{25}Mg(d,n)^{26}Al and the ^{25}Mg(^{3}He,d)^{26}Al reactions is included and discussed. (auth)

20528 THE ^{32}S(n,d)^{31}P AND ^{34}S(n,d)^{33}P REACTIONS AT 14 MeV. Wagner, R. E.; Peck, R. A. Jr. (Brown Univ., Providence). Nucl. Phys., A110: 81-90(1968).

The reactions ^{32}S(n,d)^{31}P and ^{34}S(n,d)^{33}P were examined at E_n = 14 MeV for E_d = 2 to 8 MeV and θ = 9 to 43° with thin, isotopically enriched targets and a two-pulse system of deuteron selection. Total and/or differential cross sections and absolute spectroscopic factors from DWBA analysis are reported for transitions to both ground states and to the excited states of ^{31}P at 1.27 and 2.23 MeV. No evidence was found for a state of ^{31}P at 0.45 MeV reported in an earlier study of the ^{32}S(n,d)^{31}P reaction. (auth)

20529 STATISTICAL ANALYSIS OF THE REACTION ^{51}V(p,p)^{51}V. Lamba, C. M. (Bhabha Atomic Research Center, Trombay, Bombay); Sarma, N.; Thampi, N. S.; Sood, D. K.; Deshpande, V. K. Nucl. Phys., A110: 111-28(1968).

Excitation functions of the reaction ^{51}V(p,p)^{51}V were measured at laboratory angles 100, 120, 140, and 160° in the proton energy range 4.005 to 5.515 MeV in energy steps of 5 keV with an overall resolution ≈1 keV. Rapid fluctuations observed in all excitation functions were analyzed on the basis of the theory of Ericson and Brink and Stephen. The method of Allardyce et al. and the moving average method have been incorporated to deal with the "modulation" effects. The correlation and cross section probability distribution analysis were used to extract the values of Γ, N and Y_D. The variable energy resolution method of Corti et al. to determine Γ is discussed. (auth)

20530 LEVEL STRUCTURE OF ^{46}Ti. Broman, Lars; Pullen, D. J. (Univ. of Pennsylvania, Philadelphia). Nucl. Phys., A110: 161-75(1968).

The ^{45}Sc(^{3}He,d)^{46}Ti and ^{47}Ti(^{3}He,α)^{46}Ti reactions were studied with 15 MeV ^{3}He^{2+} ions using a broad-range magnetic spectrograph. Deuteron angular distributions were measured between 7 and 60° for transitions leading to 106 states up to 11.4 MeV excitation energy in ^{46}Ti. With the aid of distorted waves calculations, proton orbital angular momentum transfers and spectroscopic strengths were obtained for states up to 7.6 MeV. Transitions to more than 30 states up to 11 MeV excitation in ^{46}Ti were also found in the (^{3}He,α) reaction study, but no ground state transition was observed. Four excited states in ^{46}Ti were identified in both reactions as probable isobaric analog states from which the Coulomb displacement energy for the ^{46}Sc-^{46}Ti pair is calculated to be 7.61 ± 0.03 MeV. (auth)

20531 DWBA STUDY OF THE ^{54}Cr(^{3}He,α)^{53}Cr REACTION. Duhm, H. H.; Stock, R.; Bock, R.; David, P.; Lynen, U. (Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 50-54 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The reaction ^{54}Cr(^{3}He,α) was measured at 18-MeV incident energy. Parameter sets for elastic scattering of α and ^{3}He particles at 16 and 19.5 MeV were used in 30 combinations for the DWBA calculation. Only the combinations with $V_\alpha \simeq V_{^3He} + 30$ MeV give acceptable fits at high Q values. The effects of angular momentum mismatch are discussed in terms of the reflection coefficients. (auth)

20532 HOLE STATES OF ^{51}V AND ^{53}Mn. Glover, R. N. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Jones, A. D. W. pp 133-5 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The distorted-wave theory was used to extract spectroscopic factors for levels in ^{51}V and ^{53}Mn that were observed through the (t,α) reaction. The positions of the s and d hole states in these nuclei are found, but the strengths of the transitions to these states are less than was expected on the basis of a simple model. (auth)

20533 THE ENERGY DEPENDENCE OF THE PHASE RULE IN THE ^{24}Mg(α,α') SCATTERING. Cramer, J. G.; Hinrichs, R. A.; Braithwaite, W. J. (Univ. of Washington, Seattle). pp 148-52 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed). New York, Academic Press, 1967.

See CONF-660906.

The energy dependence of the Blair phase rule in inelastic alpha scattering was investigated for the reaction ^{24}Mg(α,α'). A coefficient was defined which describes the relative phase between two angular distributions; it is applied to the measured elastic and first-excited-state inelastic angular distributions. This analysis shows that the phase relation is surprisingly constant over a wide range of energies, even in regions of excitation where strong cross-section fluctuations have been observed. (auth)

20534 INELASTIC SCATTERING OF ALPHA PARTICLES FROM SEVERAL NUCLEI IN THE sd SHELL. Kokame, J. (Tokyo Univ.); Fukunaga, K.; Nakamura, H. pp 153-6 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Inelastic scattering of alpha particles from ^{20}Ne, ^{24}Mg, ^{28}Si, ^{32}S, and ^{40}Ar was investigated at an incident energy of about 28 MeV for forward scattering angles (<90° lab). The collective enhancement and the deformation parameter for the first 2^+ and 3^- states were calculated by the DWBA analysis. (auth)

20535 OBSERVATION OF RESONANT STRUCTURES AT 20- TO 23-MeV EXCITATION IN ^{30}Si THROUGH THE ^{26}Mg(α,α)^{26}Mg REACTION. Singh, P. P.; Watson, B. A.; Kroepfl, J. J.; Marvin, T. P. (Indiana Univ., Bloomington). pp 245-8 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

Angular distributions of elastically scattered alpha particles from ^{26}Mg were measured in the angular range of 20 to 160° in 5° steps for an alpha energy range of 10.7 to 13.75 MeV. A phase-shift analysis of differential cross sections has revealed 14 resonant structures with unique spins and parities. Of these 1, 2, 2, 5, 1, and 3 have J^π of 1^-, 2^+, 3^-, 4^+, 5^-, and 6^-, respectively. (auth)

20536 ISOBARIC ANALOG STATES IN ^{75}As. Drory, Ch.; Marinov, A.; Mordehai, Sh.; Burde, J.; Engler, G.; Navon, E.; Tikochinsky, Y. (Hebrew Univ., Jerusalem). pp 274-7 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Resonances were observed in the excitation curves of the (p,p) reaction on ^{74}Ge, corresponding to the isobaric analog states of the ground state and the excited states of ^{75}Ge. Their center-of-mass proton energies, l_p values, total width, and proton width are obtained. A value of 9.94 ± 0.050 MeV is obtained for the Coulomb energy difference between ^{75}Ge and ^{75}As. (auth)

20537 SEARCH FOR INTERMEDIATE STRUCTURE IN NEUTRON TOTAL CROSS SECTIONS. Carlson, A. D.; Barschall, H. H. (Univ. of Wisconsin, Madison). Contract AT-11-1-gen-7. pp 278-81 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967. (TID-23400).

See CONF-660906.

The total cross sections of 19 elements from magnesium to bismuth were measured as a function of neutron energy in the MeV region, with an energy spread of 20 or 50 keV. Where fluctuations outside of the statistical accuracy of 1% were observed, they could be accounted for by level density fluctuations. It was not necessary to assume intermediate structure. (auth)

20538 THE (e,e'p) REACTION INDUCED IN CALCIUM BY 600 TO 750 MeV ELECTRONS. Amaldi, U. Jr.; Campos Venuti, G.; Cortellessa, G.; DeSanctis, E.; Frullani, S.; Lombard, R.; Salvadori, P. (Instituto Superiore di Sanita Rome). pp 324-6 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed). New York, Academic Press, 1967.

See CONF-660906.

The spectrum of scattered electron and proton coincidences as a function of missing energy, defined as the difference between the initial and the final energies, were measured in calcium as a continuation of previous work on the same high-energy nuclear reaction. Confirming previous results, high missing energies are observed. The results are discussed and are compared with existing calculations. (auth)

20539 TRANSITION PROBABILITIES IN ^{20}Ne, ^{24}Mg, AND ^{28}Si. Alexander, T. K.; Broude, C.; Ferguson, A. J.; Kuehner, J. A.; Litherland, A. E.; Ollerhead, R. W.; Smulders, P. J. M. (Chalk River Nuclear Labs., Ont.). pp 367-9 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

From radiative capture measurements, $\omega\Gamma_\gamma = 1.8 \pm 0.4$ eV was measured for the 8.79-MeV 6^+ level in ^{20}Ne; the E2 enhancement of the decay to the 4.62-MeV 4^+ level is 28 ± 7. Lifetimes of seven ^{24}Mg and nine ^{28}Si levels result from Doppler shift measurements, including strongly inhibited E2 transitions from the 6.27-MeV 3^+ and 7.79-MeV 3^+ levels in ^{28}Si. (auth)

20540 ENERGY LEVELS IN THE CALCIUM REGION. Federman, P. (Atomic Energy Research Establishment, Harwell, Eng.); Talmi, I. pp 536-9 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Nuclear energy levels of calcium isotopes up to ^{50}Ca are calculated with effective interactions in the shell model. Configurations with $1f_{\frac{1}{2}}$ and $2p_{\frac{1}{2}}$ neutrons are considered. The ^{42}Ca deformed states are also included. Good agreement between calculated and experimental energies is obtained. (auth)

20541 ENERGY LEVELS OF NICKEL ISOTOPES. Auerbach, Naftali (Weizmann Inst. of Science, Rehovoth, Israel). pp 562-5 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The spectra of the nickel isotopes are considered in the framework of the shell model. All possible configurations of neutrons outside the ^{56}Ni core and populating the $2p_{\frac{3}{2}}$, $1f_{\frac{5}{2}}$, and $2p_{\frac{1}{2}}$ orbits are taken into account. Matrix elements of the effective interaction are determined which reproduce the total energies of the even- and odd-mass isotopes of nickel. (auth)

20542 POSITIVE-PARITY STATES OF ^{43}Sc IN THE DEFORMED CORE MODEL WITH THE CORIOLIS COUPLING. Malik, F. B.; Scholz, W. (Yale Univ., New Haven). pp 589-92 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Levels, moments, and transition rates in ^{43}Sc were calculated using the Coriolis coupling model. Negative- and positive-parity states are obtained, respectively, by diagonalizing the Coriolis term with the rotational wave function based on ten 1f-2p particle and six 2s-1d hole Nilsson levels. The prediction of 17 states below 3 MeV; and the detailed prediction of spins, parities, and moments are all in accord with the experimental data. (auth)

20543 A STUDY OF DETAILED BALANCE IN THE REACTIONS ^{24}Mg(α,p)^{27}Al AND ^{27}Al(p,α)^{24}Mg. von Witsch, W.; Richter, R.; von Brentano, P. (Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 766-9 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

As a test of detailed balance, excitation functions of the reactions ^{24}Mg(α,p)^{27}Al and ^{27}Al(p,α)^{24}Mg were measured in the energy region where the cross section fluctuates strongly. The two curves agree within the errors of 4%. (auth)

20544 TEST OF INDEPENDENCE HYPOTHESIS: SPECTRA OF ALPHAS AND PROTONS FROM ^{59}Co + α AND ^{63}Ni + p. Dudey, N.; Fluss, M.; Foreman, B.; Kowalski, L.; Miller, J. (Columbia Univ., New York). pp 803-6 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

Measurements were made of the energy and angular distributions of alphas and protons emitted from a ^{63}Cu compound system at 20.2-MeV excitation formed by ^{59}Co + 15.4-MeV alphas particles and ^{63}Ni + 14.3-MeV protons. The continuum part of all four spectra have properties that are characteristic of compound-nucleus reactions, but the emitted protons do not conform to the independence hypothesis. (auth)

20545 CROSS-SECTION FLUCTUATIONS IN THE ^{27}Al(p,α)^{24}Mg AND ^{24}Mg(α,α')^{24}Mg REACTIONS. Put, L. W.; Roeders, J. D. A.; van der Woude, A. (Univ., Groningen, Netherlands). pp 797-801 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Excitation curves for the ^{27}Al(p,α)^{24}Mg* and the ^{24}Mg(α,α')^{24}Mg* reactions were measured at energies corresponding to about 26-MeV excitation of the compound system ^{28}Si. The values of the fluctuation width Γ (58 and 87 keV, respectively) and the previously measured value of 120 keV for the ^{12}C(^{16}O,α)^{24}Mg* reaction indicate that Γ depends on J, the spin of the compound system. (auth)

20546 AN INVESTIGATION OF THE ^{35}Cl(d,2α)^{29}Si GROUND-STATE REACTION. Rollefson, A. A.; Saladin, J. X.; Burke, J. A.; Crowley, P. A.; Glenn, J. E. (Univ. of Pittsburgh). pp 823-6 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The ground-state reaction ^{35}Cl(d,2α)^{29}Si was studied at a bombarding energy of 11.0 MeV. Coincident alpha particles were detected by solid-state detectors and were analyzed on a 64- by 64-channel pulse-height analyzer. The energy and angular distributions obtained are consistent with a statistical compound-nucleus interpretation. (auth)

20547 ENERGY SPECTRUM OF CHARGED PARTICLES EMITTED FOLLOWING MUON CAPTURE IN ^{28}Si. Sobottka, Stanley E.; Wills, Edward L. (Univ. of Virginia, Charlottesville). Phys. Rev. Lett., 20: 596-8(Mar. 18, 1968).

The results of a high-resolution study of the charged-particle energy spectrum resulting after μ^- capture in ^{28}Si are presented. The spectrum, attributed mainly to proton emission, exhibits a low-energy cutoff at 1.4 MeV and a maximum at about 2.5 MeV from which it decreases approximately exponentially with a decay constant of 4.6 MeV. A branching ratio of 0.15 ± 0.02 charged particle per capture was determined. (auth)

20548 THE TOTAL NEUTRON CROSS SECTION OF SULPHUR IN THE ENERGY RANGE FROM 0,0022 eV TO 0,266 eV. Maayouf, R.; Hamouda, I. (Atomic Energy Establishment, Cairo). Atomkernenergie, 13: 152(1968).

The total neutron cross section was determined for neutrons with energies ranging from 0.0022 to 0.266 eV using a time-of-flight spectrometer, which is described elsewhere. The sulphur sample of 4.5 cm diameter and 18.5 gr/cm^2 thickness, was prepared by melting pure sulphur and cooling it in an aluminium container. The measurements were carried out in two runs, one covered the energy range from 0.0022 to 0.0095 eV while the other covered the energy range from 0.008 to 0.266 eV. The fast neutron background was determined by measurement of the spectra after transmission through 1 mm of Cd both with and without sample. The values of the cross sections obtained are shown in Fig. 1. The two measured ranges are joined at 0.0095 eV, and the straight line is calculated by the least square method. The results correspond to 1/v relation that could be well represented by the formula: $\sigma_t = [(0.094 \pm 0.006)E^{-\frac{1}{2}} + (1.31 \pm 0.09)]$ barn, where E is the neutron energy in electron volts. This relation gives the potential scattering cross section $\sigma_s = 1.31 \pm 0.09$ barn and $\sigma_t(0.025\ \text{eV}) = 1.9 \pm 0.1$ barn, slightly higher than the value of 1.62 barn reported

in ANL-5800. In the range from 0.25 to 10 eV Rainwater et al. obtained the following relation for a compressed powder sample of sulphur: $\sigma_t = [(0.098 \pm 0.01)E^{-\frac{1}{2}} + (1.0 \pm 0.1)]$ barn. The first term representing the 1/v absorption cross section in the present measurements is in good agreement with the results of Rainwater et al. The second term representing the scattering cross section in these results is slightly higher than that obtained by Rainwater et al. (auth)

20549 POLARIZATION EFFECTS DURING COULOMB SCATTERING OF 4-MeV NEUTRONS BY NUCLEI OF COPPER, LEAD, AND URANIUM. Gorlov, G. V.; Lebedeva, N. S.; Morozov, V. M. Dokl. Akad. Nauk SSSR, 174: 60-3(May 1, 1967). (In Russian).

Coulomb neutron scattering is due to the interaction of the magnetic moment of a moving electron with the Coulomb field of a nucleus. On scattering an unpolarized neutron beam over small angles, the Coulombic scattering leads to an intensive polarization of the scattered neutrons and to an increase in the differential scattering cross section, as described by the equations of Schwinger [Phys. Rev., 73: 407 (1948)]. On scattering of polarized 4.0-MeV neutrons at angles of 2, 4, and 6° on Cu, Pb, and U, differential cross sections of elastic scattering in a plane perpendicular to the direction of polarization of the neutron beam, and also the total interaction cross sections of the neutrons with the nuclei were measured. The source of polarized neutrons was the D-D reaction. Scintillation stilbene counters were used to detect the scattered neutrons. Average polarization values were calculated to be 11.7 ± 3.2% for Cu, 17.5 ± 2.8% for Pb, and 15.9 ± 1.8% for U. These results are in good agreement with the predictions of Schwinger. The differential cross section of the forward elastic nuclear scattering σ_d (0°) was found to be 1.66 ± 0.12 for Cu, 7.05 ± 0.50 for Pb, and 7.40 ± 0.52 for U which compare with values of 1.51, 6.94, and 7.50 calculated theoretically from the total interaction cross section by optical theory. (TTT)

20550 MECHANISM OF THE INELASTIC SCATTERING OF PROTONS ON ^{40}Ar AND ^{48}Ti. Berinde, A. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 19: 1055-1135(1967). (In Rumanian).

As a general rule, the mechanism involving the formation of a compound nucleus predominates, if the incident particles possess low energies; the direct interaction plays an important role at the energy range above 10 to 15 MeV. These competing mechanisms were investigated for the case of the inelastic scattering of protons on ^{40}Ar and ^{48}Ti by determining the (p,p′) angular distributions and the (p,p′,γ) angular correlations and taking into account the competing (p,n) reaction. The kinematic measurements were carried out with a chamber provided with four proton detectors. It was found that the direct mechanism is important in the angular correlations and distributions in the case of scattering on ^{40}Ar. The low threshold of the (p,n) reaction is responsible for the modification of the angular correlation curve of ^{40}Ar(p,p′,γ) even at energies below the Coulomb barrier. In the case of ^{48}Ti, in which the (p,n) threshold is relatively high, the (p,n) channels do not affect the shape of the angular correlation curve; therefore, the compound nucleus mechanism predominates for ^{49}Ti in the energy range studied. The experimental data obtained show that the statistical model is able to indicate the contribution of the compound nucleus reaction. (Thesis, 85 references). (TTT)

20551 THE SCATTERING OF LOW-ENERGY ALPHA PARTICLES BY MEDIUM-WEIGHT EVEN-EVEN NUCLEI (^{54}Fe, ^{60}Ni, ^{66}Zn, and ^{68}Zn). Semenescu, G.; Ivascu, M.; Titirici, M.; Marincu, E.; Frantz, J.; Bucurescu, D. (Inst. for Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 777-80(1967).

Angular distributions of the differential cross sections for the elastic and inelastic scattering of alpha particles by ^{54}Fe, ^{60}Ni, ^{66}Zn, and ^{68}Zn were measured for incident alpha-particle energies in the range from 12 to 17 MeV. A junction detector was used to detect the alpha particles; the total resolution of the system was about 150 keV. The angular distributions for ^{54}Fe and ^{60}Ni displayed diffraction effects at energies above 16 MeV. The measurements were performed to permit the definition of optical-model parameters for medium-weight nuclei. (D.C.W.)

20552 NUCLEAR-STRUCTURE EFFECTS IN SIMPLE HIGH-ENERGY SPALLATION REACTIONS. Karol, Paul J.; Miller, J. M. (Columbia Univ., New York). Phys. Rev., 166: 1089-95(Feb. 20, 1968).

Cross sections for the (p,pn), (p,p2n), (p,2pn), and (p,2p2n) reactions at 370 MeV with ^{50}Cr, ^{58}Ni, and ^{64}Zn were determined in an investigation of the "anomalously low" ^{58}Ni(p,pn)^{57}Ni cross section of ~30 mb as compared to ~60 mb for other medium mass nuclei. All of the cross sections for these corresponding reactions were found to be lower with ^{58}Ni than with ^{64}Zn. These results rule out the explanation that the cross section for the ^{58}Ni(p,pn)^{57}Ni reaction is low because of an anomalous excitation-energy spectrum following a (p,pn) knockout reaction. Detailed consideration is given to the roles played by the one-step and two-step mechanisms and nuclear structure in determining the high-energy (p,pn) cross section. It is concluded that the current theoretical models for simple spallation reactions are able to explain the anomalous (p,pn) cross section, provided that previously ignored details of nuclear structure are taken into proper account. In the specific case of ^{58}Ni, a small nuclear skin thickness relative to neighboring nuclei can account for the low (p,pn) cross section owing to the "surface localization" of the reaction. (auth)

20553 MEASUREMENT AND DISTORTED-WAVE BORN-APPROXIMATION ANALYSES OF THE 18.7-MeV CROSS SECTIONS FOR THE ^{27}Al(α,$d_{0,1}$)^{29}Si REACTIONS. Srivastava, B. B.; Johnson, O. E. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1420. Phys. Rev., 166: 1083-8(Feb. 20, 1968). (COO-1420-129).

The 18.72-MeV differential cross sections for the ^{27}Al(α,$d_{0,1}$)^{29}Si reactions were measured from 15° to 170° at 5° intervals. Deuteron spectra were measured using an electronic spectrometer system with a particle-identification capability. Both of the measured angular distributions show forward-angle peaking, an absence of any strong oscillatory structure, and weak washed-out undulations at backward angles with a general tendency to rise at angles greater than 130°. The integrated cross sections for transitions to the ground and 1.277-MeV states of ^{29}Si are 747 ± 17 μb (16.9° to 171.3°) and 863 ± 20 μb (17.0° to 171.4°), respectively. Distorted-wave Born-approximation analyses of the data were made in terms of zero-range knockout and stripping models. In the knockout model the initial (final) nuclear state is described as a two-body system consisting of a deuteron (an α particle) bound to a ^{25}Mg core, and in the stripping model the final nuclear state is described as a deuteron bound to an ^{27}Al core. The gross features of the two angular distributions are equally well reproduced by the knockout and the stripping models. The knockout analysis requires a $2s_{\frac{1}{2}}$ state for the (d,^{25}Mg) system representing the ground state of ^{27}Al, and $2d_{\frac{5}{2}}$ and $1g_{\frac{9}{2}}$ states for the (α,^{25}Mg) system representing the ground and 1.277-MeV states of ^{29}Si, respectively. The stripping analysis requires $1d_{\frac{5}{2}}$ and $1g_{\frac{9}{2}}$ states for the (d,^{27}Al) system representing the ground and the 1.277-MeV states of ^{29}Si, respectively. Both the knockout and the stripping analyses indicate angular momentum transfers of 2 and 4 in the (α,d_0) and (α,d_1) reactions, respectively. (auth)

20554 ANGULAR DISTRIBUTION OF THE REACTION (n,α_0) ON ^{40}Ca FOR NEUTRONS OF 2.90 AND 3.28 MeV. Abaschi, Hamadi; Chambon, Bernard; Salin, Raymond; Depraz, Jean (Univ., Lyon). Compt. Rend., Ser. A and B, 265: 1127-30(Nov. 13, 1967). (In French).

The angular distribution curves of the (n,α_0) reaction on ^{40}Ca was determined for neutron energies of 2.90 and 3.28 MeV by means of junction detectors. The two curves present a very marked decrease in the vicinity of 0 and 180°. (tr-auth)

20555 MASS AND SPECTROSCOPIE MEASUREMENTS IN THE COMPLETED MASS-21 AND -37 ISOSPIN QUARTETS. Butler, Gilbert W.; Cerny, Joseph; Cosper, S. W.; McGrath, Robert L. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 166: 1096-1110(Feb. 20, 1968). (UCRL-17693).

Low-lying T = $\frac{3}{2}$ levels of the mass-21 isospin quartet (^{21}F, ^{21}Ne, ^{21}Na, and ^{21}Mg) and of three members of the mass-37 quartet (^{37}Ar, ^{37}K, and ^{37}Ca) were investigated. An improved particle-identification system which employs two transmission (ΔE) detectors and one stopping (E) detector and which permits the measurement of low-yield nuclear reactions was used to determine the masses of the $T_z = -\frac{3}{2}$ nuclei ^{21}Mg and ^{37}Ca via the (^{3}He,^{6}He) reaction on ^{24}Mg and ^{40}Ca at E_{He} = 56 MeV. The complete experimental procedures followed in these three-neutron transfer investigations are discussed. The first three T = $\frac{3}{2}$ levels in ^{21}Ne were established by a simultaneous study of the ^{22}Ne(d,t)^{21}Ne and ^{22}Ne(d,^{3}He)^{21}F reactions at 39.6 MeV, while the ^{23}Na(p,t)^{21}Na reaction at 42 MeV was utilized to observe the lowest T = $\frac{3}{2}$ level in ^{21}Na. Excitation energies of the lowest T = $\frac{3}{2}$ levels in ^{37}K and ^{37}Ar were determined via the ^{39}K(p,t)^{37}K and ^{39}K(p,^{3}He)^{37}Ar reactions induced by 45-MeV protons. Data from the complete quartets were used to test the isobaric-multiplet mass equation and the various predictions of the masses of neutron-deficient nuclei. (auth)

20556 DIFFERENTIAL CROSS SECTIONS OF THE ^{39,41}K(n,n′γ) REACTIONS. Nichols, Davis B.; McEllistrem, M. T. (Univ. of Kentucky, Lexington). Phys. Rev., 166: 1074-82(Feb. 20, 1968).

Differential production cross sections of the ^{39,41}K(n,n′γ) and ^{39}K(n,pγ) reactions were measured at incident neutron energies of 1.82, 2.63, 3.42, and 3.96 MeV. γ rays were detected with NaI(Tl) and Ge(Li) detectors using pulsed-beam techniques to eliminate backgrounds. Transition-energy measurements of the Ge(Li) detector fix the first excited state of ^{39}K at 2.519 ± 0.003 MeV. In-

terpretation of the γ-ray angular distributions and production cross sections permitted spin assignments to ^{39,41}K levels. The ^{39}K levels assigned (excitation in MeV, spin) are 2.817, 7/2; 3.021, 3/2; 3.603, 5/2. Those assigned in ^{41}K are 0.978, 1/2 or 3/2; 1.291, 7/2; 1.58, 5/2 or 11/2. (auth)

20557 GAMMA RAYS FROM THE ^{75}As(n,γ)^{76}As REACTION. Morcos, N. A.; Barnes, R. O.; De Melo, J.; Lee, B. E.; Van Hise, J. R. (Andrews Univ., Berrien Springs, Mich.). Phys. Rev., 166: 1068-73(Feb. 20, 1968).

Neutron capture γ rays from ^{76}As were studied. In this study 2 kg of ^{75}As were irradiated with thermal neutrons from a 5-Ci Pu-Be Source. Graphite and paraffin were used to thermalize the fast neutrons. The As nearly surrounded an encapsulated Ge-Li detector, which detected the high-energy γ rays from the As with an energy resolution of 12 keV. Several centimeters of lead and bismuth between the Pu-Be source and the detector attenuated the γ radiation emitted from the Pu-Be source. Energies and intensities of 38 γ rays were measured in the region between 5.2 and 7.3 MeV. The 5.718-, 6.114-, and 6.632-MeV γ rays of ^{36}Cl were used as energy and intensity standards. The highest-energy γ rays observed has an energy of 7344 ± 10 keV. Assuming this to be the transition from the capture state to the ground state and the others to de-excite the capture state also, 37 energy levels are found from the ground state up to 2100 keV. Additionally, two previously unresolved energy regions in the ^{35}Cl(n,γ)^{36}Cl spectrum are resolved. (auth)

20558 ISOTOPES OF TIN AND THE OSMOTIC PROPERTIES OF POLYSTYRENE SULFONATE SYSTEMS. Chu, Pochen. Buffalo, N. Y., State Univ. of New York, 1967. 143p.

Thesis.

Evidence is presented to indicate that the 1 hr isomeric state of ^{129}Sn reported in the literature does not exist. Its observation appears to have been an artifact of the chemical procedure that was employed. A rapid separation procedure based on sodium iodide-benzene extraction was developed. By its use, a 2 min ^{129}Sn and a 1 min ^{133}Sn were discovered. The osmotic properties of nine polystyrene sulfonates were studied by the differential osmometry method in the presence or absence of uni-univalent salts. The applicability of the cylindrical model to the polyelectrolyte solutions was critically tested by the experimental results obtained in this work. Parameters associated with this model, especially the effective chain length, were calculated with the aid of a computer. (Diss. Abstr.)

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Refer also to abstracts 18738, 20045, 20127, 20129, 20404, 20405, 20475, 20497, 20498, 20513, 20523, 20537, 20549, 20684, 20692, 20697, 20726, 20741, and 20975.

20559 (AERE-R-5086) YIELDS FROM NEUTRON INDUCED FISSION. Croall, I. F. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1965, Reprinted Jan. 1968. 29p. Dep. CFSTI. UK 4s. 6d.

A survey of yields from the thermal and fast neutron-induced fission of ^{233}U, ^{235}U, ^{239}Pu, and ^{241}Pu, and from the fast neutron fission of ^{232}Th and ^{238}U is presented. (auth) (UK)

20560 (AERE-R-5342) GAMMA-RAY BRANCHING RATIO IN THE DECAY OF ^{95}Zr. Hiscott, J. E. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). Jan. 1968. 12p. Dep. CFSTI. UK 2s. 6d.

An investigation was made of the gamma-ray spectrum of ^{95}Zr/^{95}Nb, using a lithium-drifted germanium detector, with the object of determining the intensities of the 724- and 756-keV transitions in the decay of ^{95}Zr. Since the 764-keV transition in ^{95}Nb was not completely resolved, a mathematical analysis of spectra, obtained over several weeks from materials with differing Zr : Nb ratios, was made; and measurements on chemically separated Zr were studied. The intensity of the 724-keV transition was determined to be 43.5%, while the intensity of the 756-keV transition was determined to be 54.5%. (auth)

20561 (AHSB(S)R-141) NEUTRON INTERACTION IN THE ENERGY RANGE 1.0 E-10 MeV TO 15.0 MeV. Hart, W. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). Mar. 1968. 42p. Dep. CFSTI. UK.

In the past few years, some high-resolution measurements have been performed which, when combined with theoretical predictions, afford a detailed description of neutron interactions with the nuclide tantalum. From these and other sources of information, a set of neutron cross sections and other relevant parameters have been evaluated. They cover the energy range 1×10^{-5} to 15 MeV and are presented as a new data file (DFN346) for the UKAEA Nuclear Data Library. (auth)

20562 (BNL-12263) THE THERMAL CROSS SECTIONS AND PARAMAGNETIC SCATTERING CROSS SECTIONS OF THE Yb ISOTOPES. Mughabghab, S. F.; Chrien, R. E. (Brookhaven National Lab., Upton, N. Y.). [1967]. 13p. (CONF-680307-8). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

The total cross sections of oxide samples highly enriched in ^{170}Yb, ^{171}Yb, ^{172}Yb, ^{173}Yb, ^{174}Yb, and ^{176}Yb were measured at the BNL fast chopper at the BGRR, using 9.9- and 29.74-m flight paths. The total cross sections of the isotopes are found to be 17.0 ± 1.0 b, 57 ± 3 b, 10.2 ± 1.5 b, 28 ± 2 b, 142 ± 5 b, 14.9 ± 1.0 b, respectively. An average value of 5.2 ± 0.9 b was obtained for the paramagnetic scattering cross section of Yb^{+++} at 0.0253 eV, from the measurement on ^{170}Yb, ^{172}Yb, and ^{176}Yb, contrasted with a value of 26.1 ± 2.5 b for Er^{+++}. When the isotopic total cross sections are compounded to form the total cross section of Yb, a value of 67.6 ± 2.0 b is obtained. This is based in part on a thermal value of 3795 ± 760 b for ^{168}Yb which is calculated from the resonance parameters. Finally, the absorption and the nuclear scattering cross sections of these isotopes at 0.0253 eV are discussed. (auth)

20563 (BNL-12269) NEUTRON CROSS SECTION AND RESONANCE INTEGRALS OF HOLMIUM. Stephenson, Thomas E. (Brookhaven National Lab., Upton, N. Y.). [1967]. 12p. (CONF-680307-11). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

Previously reported calculations were extended. Resonance parameters for 76 resonances of Ho below 500 eV, selected from the literature and from values compiled and recommended in BNL 325, are used as the starting point in fitting the total neutron cross section data to a Breit-Wigner multilevel scattering and single-level absorption formula. The addition of two bound levels, one for each s-wave spin state, yields a calculated ratio of thermal neutron capture cross sections for the two spin states which agrees with experiment (~60% for J = 3), as does the calculated value of the thermal capture cross section, 67 b. In addition, the two bound levels enable the fit of the total cross section data to be extended to very low energies (0.2 mV). The energy-dependent paramagnetic scattering cross section (23.5 b at 0.0253 eV) and the capture and scattering resonance integrals were also calculated (~672 and 125 b, respectively). (auth)

20564 (CONF-680307-13) ELASTIC SCATTERING OF FAST NEUTRONS BY PRASEODYMIUM AND LANTHANUM. Bernard, D. L.; Lenz, G. H.; Reber, J. D. (Virginia Univ. [Charlottesville]). [1967]. 11p. Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

The differential cross section for the elastic scattering of fast neutrons by praseodymium and lanthanum was measured for an incident neutron energy of 8.00 MeV from 25 to 155° in the laboratory system. A pulsed-beam neutron time-of-flight spectrometer was used in conjunction with a Mobley buncher and a 12.7-cm diameter NE102 plastic scintillator. The absolute differential cross section was normalized to the n-p differential cross section at 40° in the laboratory system. (auth)

20565 (CONF-680307-18) ESTIMATED FISSION PROPERTIES OF TRANSRADIUM ISOTOPES. Prince, A. (Brookhaven National Lab., Upton, N. Y.). [1968]. 88p. Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

A systematic procedure for estimating thermal neutron fission and capture neutron cross sections and the fission and capture resonance integrals for transradium isotopes is outlined. The method involves establishing a correlation between the difference of the binding energy and fission threshold ($B_n - E_f$) and the cross sections and resonance integrals. Estimated values for σ_f, σ_γ, I_f, I_γ, the average number of prompt neutrons (ν_p), α, η, and the average kinetic energy of fission fragments ($\langle E_k \rangle$) are given. The method of analysis and recommendations for further study and possible improvements are presented. (auth)

20566 (DP-MS-67-111) REACTOR CROSS SECTIONS FOR ^{242}Pu-^{252}Cf. Smith, J. A.; Banick, C. J.; Folger, R. L.; Holcomb, H. P.; Richter, I. B. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Feb. 28, 1968. Contract AT(07-2)-1. 9p. (CONF-680307-10). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

A self-consistent set of cross sections for nuclides in the chain ^{242}Pu through ^{252}Cf was deduced from measured contents of ^{242}Pu samples exposed to nvt levels of 4 to 9×10^{22} n/cm^2 in a highly thermalized neutron spectrum. Some nuclides in the chain exhibit finite cross sections for fission as well as capture, so there are more cross sections to be determined than there are measurements. Independent measurements were used to complete the set. (auth)

20567 (DP-MS-67-112) FOIL MEASUREMENTS OF INTEGRAL CROSS SECTIONS OF HIGHER MASS ACTINIDES. Folger, R. L.; Smith, J. A.; Brown, L. C.; Overman, R. F.; Holcomb, H. P. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Mar. 1, 1968. Contract AT(07-2)-1. 7p. (CONF-680307-6). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

Thermal and resonance integral capture cross sections were deduced for ^{242}Pu, ^{243}Am, ^{244}Cm, ^{245}Cm, ^{246}Cm, ^{249}Bk, ^{250}Cf, ^{252}Cf, and ^{253}Es from measurements of activation products in unshielded and cadmium-covered thin targets which were irradiated in high-flux charges at Savannah River. Analytical uncertainties in chemical yields were minimized by extensive use of mass spectrometry and alpha pulse energy analysis to determine isotope ratios. The nvt exposures were monitored by the ^{59}Co(n,γ)^{60}Co reaction. The capture cross sections for ^{242}Pu, ^{246}Cm, ^{249}Bk, and ^{252}Cf were used to complete the set of self-consistent cross sections for the chain ^{242}Pu through ^{252}Cf. (auth)

20568 (GEMP-587) EVALUATION OF ^{185}Re AND ^{187}Re NEUTRON CROSS SECTIONS FOR THE ENDF/B LIBRARY. Henderson, W. B.; Zwick, J. W. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). [1967]. Contract AT(40-1)-2847. 32p. (CONF-680307-1). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

The neutron cross sections of ^{185}Re and ^{187}Re from 10^{-5} to 1.5×10^7 eV have been evaluated and placed in the ENDF/B library format. The cross sections in the energy range 10^{-5} to 10^2 eV are described by resonance parameters reported by Friesenhahn et al., except for bound levels, where parameters were assigned to fit the measured cross sections at thermal energies using multi-level Breit-Wigner calculations. In the range 10^2 to 10^5 eV the cross sections are described by unresolved resonance parameters for s- and p-wave contributions, and a smooth correction cross section is used to compensate for omission of higher-order contributions. In the range 10^5 to 1.5×10^7 eV smooth cross sections are given which were obtained for the most part from optical model calculations using parameters which produce good agreement with the measured total cross section. Comparisons with measured elastic, inelastic, radiative capture, and (n,2n) cross sections, as well as reactivity worth and absorption integrals, were also used to evaluate the parameters in the nuclear models, the results from which were then supplied as the evaluated cross sections. (auth)

20569 (HNS-1229-77) CALCULATED ACTIVITIES OF LONG-LIVED FISSION PRODUCTS PRODUCED BY VARIOUS NEUTRON-INDUCED FISSION PROCESSES. Castagnola, D. C. (Hazleton-Nuclear Science Corp., Palo Alto, Calif. Earth Sciences Div.). Feb. 1967. Contract AT(29-2)-1229. 21p. Dep. CFSTI.

The radioactivities, expressed in units of curies per kiloton, are calculated for long-lived fission products which result from nuclear fission of ^{233}U, ^{235}U, and ^{239}Pu by thermal neutrons; from fission of ^{233}U, ^{235}U, and ^{239}Pu by fission spectrum and 14-MeV neutrons; and from fission of ^{238}U by neutrons produced during a thermonuclear explosion. Because of the long time scale associated with ground-water hydrology, only products with half-lives greater than one-half year are considered. (auth)

20570 (ITEF-52) MUL'TINOL'NOST PEREKHODA S ENERGIEI 341 keV, SOPROVOZHDAYUSHCHEGO ZAKHVAT TEPLOVYKH NEITRONOV Ti^{48}. (Multipolarity of the Transition With 341 keV Energy Accompanying the Capture of Thermal Neutrons by ^{48}Ti). Tret'yakov, E. F.; Danilyan, G. V.; Pavlov, V. S.; Grishuk, G. I.; Konyaev, V. F. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 16p. (In Russian). Dep.

The internal conversion coefficient of the 341-keV transition accompanying the capture of thermal neutrons by ^{48}Ti was measured. The value $\alpha = 0.95 \pm 0.14 \times 10^{-3}$ obtained within the errors coincides with the table value of α for an M1 transition. This result, together with the data available on the angular correlation measurements allows one to make a choice between two possible values of the mixing parameter $\delta = +2.2$ or $\delta = -0.1$ in the favor of the latter one. In the control experiments intended to test the ICC absolute measurement method, the internal conversion coefficient for the 323-keV transition in ^{51}V $\alpha = 1.45 \pm 0.14 \times 10^{-3}$ as well as the intensity of the 341-keV transition in ^{49}Ti per neutron captured, $\nu = 0.33 \pm 0.08$ were determined. (auth)

20571 (LA-DC-9188) TECHNIQUES FOR FISSION CROSS-SECTION MEASUREMENTS FOR ELEMENTS WITH HIGH α AND SPONTANEOUS FISSION ACTIVITY. Koontz, Philip G.; Barton, David M. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 9p. (CONF-680307-22). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

Some considerations involved in measuring the neutron-induced fission cross sections of high specific activity in alpha emitters are discussed, and a technique using solid-state detectors combined with fast solid-state circuits described. Amplitude discrimination alone can be used to distinguish between alpha and fission events and the alpha pile-up controlled by resolving individual pulses. This technique can be extended to isotopes with a high specific activity from spontaneous fission by using time discrimination. A Mobley buncher on a Van de Graaff accelerator with time coincidence is used to discriminate against the random spontaneous fission events. The results obtained for ^{238}Pu (3.8×10^7 alpha/min/μg) and ^{244}Cm (1.8×10^6 alpha/min/μg – 232 fiss/min/μg spontaneous fission) for several neutron energies are presented to illustrate the discussion. (auth)

20572 (LA-DC-9205) RELATIVE FISSION CROSS SECTIONS OF ^{236}U, ^{238}U, ^{237}Np, AND ^{235}U. Stein, W. E.; Smith, R. K.; Smith, H. L. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 12p. (CONF-680307-24). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

The fission cross-section ratios ^{236}U/^{235}U, ^{238}U/^{235}U, and ^{237}Np/^{235}U were measured with pulsed, monoenergetic neutrons in the energy range 1.0 to 5.0 MeV with time-of-flight background discrimination. Vacuum evaporated fissile deposits (~0.5 mg/cm^2) were placed back to back between two 9.5 cm^2 surface barrier detectors. Slow and fast output signals were obtained simultaneously from each detector by means of separate electronic systems. Slow, linear pulses which exceeded a lower bound set to reject alpha particles were identified as fission events. The fraction of fragment pulses below this bias, determined from an extrapolation of the pulse-height spectrum, was ~1.2%. Only those fission events which occurred during and a few nanoseconds after the neutron burst were recorded. This time interval, determined by the measured time resolution (1.3 nsec FWHM) and the time walk of the smallest pulses (~2 nsec), was typically 6 nsec. Fission events induced by scattered neutrons which occur at later times were excluded. Characteristics of this detector system and preliminary data were reported earlier. Present results include additional data on ^{238}U/^{235}U and ^{237}Np/^{235}U and new data on ^{236}U/^{235}U. (auth)

20573 (LYCEN-6781) CONTRIBUTION A L'ETUDE DES REACTIONS (α,xn) SUR L'HOLMIUM ET LE THULIUM A BASSE ET MOYENNE ENERGIE. APPLICATION A LA PREPARATION D'ISOTOPES DEFICIENTS EN NEUTRONS DU THULIUM ET DU LUTECIUM. (Contribution to the Study of the Reactions (α,xn) on Holmium and Thulium at Low and Medium Energies. Application to the Preparation of Neutron-Deficient Isotopes of Thulium and Lutetium). Demeyer, Albert (Lyon Univ. (France). Institut de Physique Nucleaire). Nov. 1967. 112p. (In French). Dep.

Thesis.

The preparation and identification of the reaction products obtained by bombardment of ^{165}Ho and ^{169}Tm with α particles were studied. The determination of the absolute cross sections made it possible to choose the energy value where the probability for the formation of a given isotope is a maximum. The estimation of the ratio of the absolute cross sections of the isomers, for a high excitation energy of the nucleus, is generally sufficient to identify the isomer spin state of the ground state. The (α,xn) excitation functions furnish a test for the region of validity of the statistical theory. It was proposed to interpret the behavior of these functions at high energies within the framework of quantum mechanics using the Born approximation. The establishment of these excitation functions made it possible to discuss the parameters and quality of the α particle beam of the synchrocyclotron at Lyon. The experimental results made it possible to prepare sources designed for the β- and γ-spectrometric study of their nuclear schemes. Various techniques for rapid separation and deposition in thin foils were developed. (J.S.R.)

20574 (LYCEN-6785) ETUDE DU FACTEUR g DU PREMIER ETAT EXCITE DU ^{196}Pt. (Study of the g-Factor of the First Excited State of ^{196}Pt). Levy, Michele (Lyon Univ. (France). Institut de Physique Nucleaire). Dec. 1967. 64p. (In French). Dep.

Thesis.

The g-factor of the first excited state of ^{196}Pt was measured by the integral method of perturbed angular correlations. Two types of sources were used: a classical Fe–Au alloy and a source where the ^{196}Au ions are injected in an ion target using an isotopic separator provided with post acceleration. Thus it is possible to compare the magnetic fields that predominate in the two types of sources and perhaps draw conclusions on the respective positions of the Pt nucleus in the crystalline lattice of Fe. Before the description of the experimental studies, a study is given of the even isotopes of Pt using the rotational-vibrational model. A perfect agreement was found between the experimental value and the theoretical values predicted for the calculations of Kumar and Baranger based on the rotational-vibrational model. It was deduced that the nuclei ^{192}Pt, ^{194}Pt, and ^{196}Pt are nuclei which vibrate around a position more or less deformed according to the isotope considered. The measurements made justify the supposition of Kalish, et al., that it is possible to measure the g-factors of the excited levels of neighboring isotopes with the aid of Coulomb implantation if one of the g-factors is known and if the lifetimes of the various levels are of the same order of magnitude or at least equal to several picoseconds. (J.S.R.)

20575 (NP-17285) ETUDE DU SPECTRE GAMMA DE BASSE ENERGIE DE LA DESINTEGRATION ^{231}Th → ^{231}Pa. (Study of the Low-Energy Gamma Spectra of the ^{231}Th → ^{231}Pa Decay). Pelletier, Anne-Marie (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1966. 34p. (In French). Dep.

Thesis. Submitted to Univ. of Grenoble, Faculte des Sciences, France.

The low-energy γ spectra from the ^{231}Th → ^{231}Pa decay detected with a sodium iodide crystal were studied. The ratio of the intensity of the γ transitions at 25.6 and 84.1 keV was examined in detail. For the preparation of a concentrated solution of ^{231}Th, the ^{235}U and ^{231}Th were separated on anion resin, and the Th was entrained by Fe. The Fe-entrained Th was then fixed on cation resin and reextracted by oxalic acid. A technique for the measurement of the low-energy γ spectra was developed. The ratio of the intensities of the transitions at 22 and 88 keV of the ^{109}Cd spectra was evaluated as 24.0 ± 0.6. These data are in good agreement with that found by others and were used to test the reliability of the apparatus. A numerical method for analysis of a complex γ spectrum of ^{231}Th was studied. The analysis method has the inconvience of being tedious. The ^{231}Th spectrum measured up to 120 keV shows a distribution of the rays. The energies of the rays are those of the peaks of the ^{231}Th spectra detected by a γGe(Li) junction. The dispersion of the results on the intensities of the rays is probably due to imprecision in the measurements caused by the derivative of the electronic devices. A spectra stabilizer is necessary for more precise measurements. The ratio of the intensities of the rays at 25.6 and 84 keV was evaluated to be 1.8 ± 0.2. (tr-auth)

20576 (ORNL-TM-2159) SOME RECENT NUCLEAR CROSS SECTION MEASUREMENTS AT ORNL, OCTOBER 1, 1967–FEBRUARY 29, 1968. Stelson, P. H. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 20p. Dep. CFSTI.

Some recent measurements of differential cross sections and γ spectra for the reactions ^{14}N(n,n')^{14}N, ^{14}N(n,p)^{14}C, and ^{14}N(n,α)^{11}B; the neutron total cross section of ^{16}O; γ spectra from resonance and thermal neutron capture by ^{140}Ce, ^{39}K, ^{41}K, ^{185}Re, ^{187}Re, ^{203}Tl, ^{205}Tl, ^{112}Sn, ^{114}Sn, and ^{115}Sn; and capture and fission cross sections for ^{239}Pu from thermal to 30 keV and for ^{233}U from thermal to 1 eV are summarized. Calculations of the elastic and inelastic scattering cross sections for ^{56}Fe are also reported, as is the status of the electron linear accelerator. (D.C.W.)

20577 (UCRL-70826) NEUTRON SCATTERING CROSS SECTIONS OF ^{233}U, ^{235}U, AND ^{241}Pu FROM 1 TO 30 eV. Sauter, G. D.; Bowman, C. D. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 28, 1968. Contract W-7405-eng-48. 16p. (CONF-680307-9). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

Scattering measurements of ^{233}U, ^{235}U, and ^{241}Pu were made at the Livermore linear electron accelerator using the 4π neutron source technique. Scattering cross sections, corrected for effects of sample thickness, were obtained for neutron energies between 1 and 30 eV. For ^{241}Pu, the scattering cross section and published fission data were simultaneously fitted with Reich and Moore's multilevel formula. A good fit to both cross sections could only be obtained by allowing a sizeable fluctuation in the capture widths. Spin assignments were for all resonances in the 1 to 30 eV interval. The resulting resonance parameters are presented. The results of a similar fit to ^{233}U, was less successful and no spins were obtained. The ^{235}U scattering cross section was not sufficiently detailed for meaningful multilevel analysis. (auth)

20578 (WASH-1079) REPORTS TO THE AEC NUCLEAR CROSS SECTIONS ADVISORY COMMITTEE. Meeting held at Idaho Falls, Idaho, October 17–18, 1967. Moore, M. S. (comp.) (Idaho Nuclear Corp., Idaho Falls). 209p. (EANDC(US)-104-U; INDC(US)-2-U). Dep. CFSTI.

Progress in numerous investigations of neutron reactions and charged-particle reactions is summarized. Information, in varying degrees of completeness, is given on cross sections, resonance parameters, and level schemes. Some developments in instrumentation are also outlined. (D.C.W.)

20579 THE NUCLEAR QUADRUPOLE MOMENT OF ^{189}Os. Himmel, G. (Technische Hochschule, Hanover). Z. Phys., 211: 68-88(Mar. 12, 1968). (In German).

The hyperfine structure of 11 Os I-lines in the violet and ultraviolet spectral range was investigated by a digital recording Fabry Perot spectrometer. An enriched sample of ^{189}Os was used in the hollow cathode light source. The recorded structures were analyzed on a computer. The quadrupole coupling constants of the states $5d^6\,6s^2\,{}^5D_2$, ${}^5D_3$, ${}^5D_4$, and $5d^7\,6s\,{}^5F_5$ or linear combinations of these coupling constants were deduced from the measurements. With these results the nuclear quadrupole moment of ^{189}Os was determined to be $Q(^{189}Os) = 0.91 \pm 0.10 \times 10^{-24}$ cm^2. This was done using the eigenfunctions of Gluck, Bordarier, Bauche, and van Kleef, which have been calculated for intermediate coupling considering configuration interaction. (auth)

20580 ELECTRIC NUCLEAR QUADRUPOLE MOMENT OF ^{134}Cs. Heinzelmann, G.; Knohl, U.; zu Putlitz, G. (Univ., Heidelberg). Z. Phys., 211: 20-34(Mar. 12, 1968). (In German).

The hyperfine structure splitting of the $7^2P_{\frac{1}{2}}$ state of ^{134}Cs was measured by optical double resonance spectroscopy in zero magnetic field. The following interaction constants have been obtained: magnetic hfs constant $A(7^2P_{\frac{1}{2}}, {}^{134}Cs) = 16.851(16)$ MHz; quadrupole coupling constant $B(7^2P_{\frac{1}{2}}, {}^{134}Cs) = 18.07(12)$ MHz; then the electric quadrupole moment of ^{134}Cs can be calculated $Q_{Sth}(^{134}Cs) = +0.436$ (3) b without Sternheimer correction, and $Q(^{134}Cs) = +0.356(2)$ b with Sternheimer correction. A method for the production of alkali resonance cells with quantities of less than 10^{14} atoms of the radioactive isotope is described. (auth)

20581 INTERNAL CONVERSION STUDY OF THE DECAY OF ^{193}Au. Svahn, B.; Johansson, A.; Nyman, B.; Malmsten, G.; Pettersson, H. (Univ. of Uppsala). Z. Phys., 210: 466-89(1968).

The internal conversion spectrum following the decay of ^{193}Au was studied in the electron energy region 0.8 to 700 keV, with the use of high-resolution magnetic beta-ray spectrometers. Several not previously reported transitions were established. Multipolarities and mixing ratios were deduced from K/L and subshell intensity ratios, and the majority of the transitions were found to be of M1 and/or E2 characters. A revised level scheme for ^{193}Pt, which consistently accommodates most transitions, was constructed. Tentative spin-parity values were assigned to all levels. (auth)

20582 DECAY OF ^{143}Sm. De Frenne, D.; Heyde, K.; Dorikens-Vanpraet, L.; Dorikens, M.; Demuynck, J. (Univ., Ghent). Nucl. Phys., A110: 273-80(1968).

The decay of ^{143}Sm was investigated by means of a Ge(Li) spectrometer. Levels of ^{143}Pm at 272.9, 1056.6, 1173.3, 1341.0, 1403.5, 1515.7, 1751.3, 1816.8, 2009.6, 2081.2, and 2172.5 keV were established. Gamma-gamma coincidences confirmed the existence of the 272.9 keV level. Spin and parity assignments for all observed levels have been suggested from electron capture and positon disintegration considerations and gamma branches. The level scheme is compared with an extreme one-quasi-particle model and an extended one-plus-three-quasi-particle Tamm-Dancoff approximation. (auth)

20583 BETA PARTICLES AND CONVERSION ELECTRONS FROM THE DECAY OF ^{96}Nb. Antman, S.; Pettersson, H.; Grunditz, Y. (Univ. of Uppsala). Nucl. Phys., A110: 289-99(1968).

The beta particle and conversion electron spectra from the decay of 23-h ^{96}Nb were investigated using a 50 cm radius double-focussing spectrometer. The beta spectrum could be resolved into three different branches. The 1195 ± 20 keV branch followed a half-life of 60 ± 18 h and was tentatively assigned as a previously unreported isomeric transition from a niobium isotope. Conversion coefficients were obtained for most transitions by combining the conversion intensities of this work with earlier reported gamma-ray intensities. Based on sum relationships for the transition energies the earlier stated doublet structure of the 2.44 MeV level is rejected. A tentative decay scheme is given, which for the most part resembles that of previous investigations. (auth)

20584 EXPERIMENTAL STUDY OF THE STRUCTURE OF ^{90}Y. Mishra, N. (Univ. of Texas, Austin); Moore, C. Fred; Watson, C. E. Nucl. Phys., A110: 353-65(1968).

Angular distributions of the ^{89}Y(d,p)^{90}Y reaction were measured at an incident deuteron energy of 12 MeV. Agreement with previous work for the low-lying strongly excited levels is found. Clarification of the structure of the weakly excited states at high excitation energies is provided by this study. Fits to the experimental angular distributions are made using DWBA calculations. A comparison of the level structure of other 51-neutron nuclei is made and qualitative agreement is found particularly in the systematic occurrence of doublets for each known single-particle state in this region. These states were previously studied by analog resonances in elastic and inelastic proton scattering. Also, a comparison is made with the calculations of Ramavataram, who used a Soper-exchange mixture whose general features are the same as the free nucleon-nucleon potential. (auth)

20585 COLLECTIVE VIBRATIONAL STATES IN EVEN DYSPROSIUM NUCLEI. Grotdal, T.; Nyboe, K.; Thorsteinsen, T. (Univ. of Bergen, Norway); Elbek, B. Nucl. Phys., A110: 385-99(1968).

The energy levels of the even Dy nuclei were investigated by inelastic scattering of 12 MeV deuterons. A magnetic spectrograph was used to record the deuteron spectra with an over-all energy resolution of ≈8 keV. Below an excitation energy of approximately 2.5 MeV, collective octupole states, collective γ-vibrations and in some cases β-vibrations were identified. The identifications were based on semi-empirical rules governing intensities and angular distributions of the inelastic groups. For each nucleus, most of the octupole strength was found in a single state at approximately 1300 keV excitation. There is some evidence for this state to have $K^{\pi} = 2^-$. (auth)

20586 STUDY OF THE EXISTENCE OF THE ISOMER OF ^{172}Lu WITH $T_{\frac{1}{2}}$ = 4 HR. Badescu-Singureanu, Al. I.; Grecescu, M.; Ionescu, V. A.; Nascutiu, T. (Institut de Physique Atomique, Bucharest). Rev. Roum. Phys., 12: 803-7(1967). (In Rumanian).

An attempt was made to observe the production of a 4-hr isomer of ^{172}Lu by the reaction ^{169}Tm(α,n)^{172}Lu. A target consisting of thulium oxide on a gold backing was irradiated with 14-MeV alpha particles, and gamma spectra were measured using a scintillation counter. Activities with half-lives of 3.6 hr and 6.7 day were observed and were attributed to ^{61}Cu and an isomer of ^{172}Lu, respectively. No evidence of an activity with a half-life of 4 hr was observed. (D.C.W.)

20587 CORRELATIONS IN PARTIAL WIDTHS OF NEUTRON-INDUCED REACTIONS. Beer, M.; Lone, M. A.; Chrien, R. E.; Wasson, O. A.; Bhat, M. R.; Muether, H. R. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 20: 340-3(Feb. 12, 1968). (BNL-12011).

A significant positive correlation between reduced neutron and radiative widths in ^{169}Tm(n,γ)^{170}Tm reactions is demonstrated. This verifies suggestions by Lane and Lynn [Nucl. Phys. 17: 563(1960)] that anomalously strong E1 transitions occur to final states having a largely single-particle character in resonances of thermal neutron capture (internal and channel resonant capture). (S.F.L.)

20588 INELASTIC DEUTERON SCATTERING FROM ^{148}Sm, ^{150}Sm, ^{152}Sm, AND ^{154}Sm. Veje, E.; Elbek, B.; Herskind, B.; Olesen, M. C. (Univ. of Copenhagen). Nucl. Phys., A109: 489-506(1968).

Targets of ^{148}Sm, ^{150}Sm, ^{152}Sm, and ^{154}Sm were bombarded with 12.1 MeV deuterons and the spectra of inelastic deuterons observed at 60°, 90°, 125°, 125°, and 155° by means of a high resolution magnetic spectrograph. For the strongly populated levels the multipolarities of the excitations were determined from the slopes of the angular distributions which are characteristic functions of the multipolarity. The cross sections from the 2^+ and 3^- states were compared to the corresponding reduced transition probabilities B(Eλ) determined by Coulomb excitation with 15 or 16 MeV α-particles. On this basis, a normalization was obtained which allowed the extraction of reduced transition probabilities from the yields of inelastically scattered deuterons. The results are compared to previous studies and the nature of some of the states observed is discussed. (auth)

20589 ENERGY LEVELS OF ^{90}Nb POPULATED BY THE DECAY OF ^{90}Mo. Cooper, J. A.; Hollander, J. M.; Rasmussen, J. O. (Univ. of California, Berkeley). Nucl. Phys., A109: 603-24(1968).

The energy levels of ^{90}Nb populated by the decay of 5.7 h ^{90}Mo were studied with the use of high-resolution germanium γ-ray spectrometers. The γ-ray spectrum revealed a number of low-intensity transitions in addition to the intense 122 and 257 keV lines. The multipolarities of most of these transitions were determined by means of K-shell conversion coefficients, which were calculated from the photon intensities measured in this work together with previously reported conversion electron intensities. In addition, coincidence relationships among the more intense transitions were studied with γ-γ coincidence systems using Ge(Li)-Ge(Li) and Ge(Li)-NaI(Tl) detectors. These and previously reported data were used to construct a decay scheme in which all of the transitions of greater than 1% intensity are placed. The low-energy transition depopulating the 24 sec isomeric state was not observed directly, but from lifetime considerations its multipolarity is interpreted as M2, and from energy differences its energy is inferred as 2.38 ± 0.36 keV. (auth)

20590 MEASUREMENT OF (n,2n) REACTION CROSS SECTIONS AND ANALYSIS OF THE SPIN DISTRIBUTION OF BOTH INDIUM ISOTOPES. Rotzer, H. (Institut fuer Radiumforschung und Kernphysik, Vienna). Nucl. Phys., A109: 694-6(1968). (In German).

The (n,2n) cross sections of ^{113}In and ^{115}In for the production of the isomers and of the ground states of the product nuclei were measured. The isomer cross-section ratios were compared with calculated values obtained from the Vandenbosch-Huizenga formalism. Values of the spin distribution parameter σ were deduced from this comparison. (S.F.C.)

20591 HALF-LIFE OF ^{208}Tl (ThC''). Lassen, N. O.; Hornstrup, N. Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Medd., 36: 16p(1967).

The half-life of ThC'' was measured to be 3.055 ± 0.006 min or 183.3 ± 0.4 sec, which is 1.5% smaller than the best previously known value. (auth) (Denmark)

20592 DECAY OF THE 55-min and 12-min ^{133}Te ISOMERS. Parsa, Bahman; Gordon, G. E.; Walters, W. B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-905. Nucl. Phys., A110: 674-94(1968). (MIT-905-106).

Gamma rays emitted in the decay of the ^{133}Te isomers, 55.4-min ^{133m}Te and 12.5-min ^{133g}Te, were observed with Ge(Li) detectors. Sources were prepared by separating Sb from fission products, allowing several minutes for decay of 2.7-min ^{133}Sb and then separating the Te daughter activities. A total of 29 γ rays between 312 and 2541 keV were attributed to decay of ^{133g}Te and 30 from 74 to 2050 keV to that of ^{133m}Te. Gamma-gamma coincidences in the decay of ^{133g}Te were observed with a NaI(Tl)-Ge(Li) set-up. The decay scheme of ^{133g}Te was constructed, involving placement of 25 of the γ rays emitted. The decay of ^{133g}Te populates levels in ^{133}I at 0, 312, 720, 787, 1313, 1333, 1374, 1565, 1718, 2137, 2194, and 2541 keV. The decay of ^{133m}Te is very complicated, and no attempt was made to construct a complete decay scheme. However, levels at 913 and 1561 keV in ^{133}I are definitely populated in ^{133m}Te decay. The value of Q_β of ^{133}Te was measured as 3.52 ± 0.10 MeV. The low-lying levels of the odd-mass iodine isotopes vary smoothly through the series ^{125}I through ^{133}I. The levels of ^{133}I are fitted rather well by predictions based on quasi-particle-phonon coupling. (auth)

20593 MOESSBAUER EFFECT STUDIES OF THE 74.5-keV LEVEL OF ^{161}Dy. Khurgin, B.; Ofer, S.; Rakavy, M. (Hebrew Univ., Jerusalem). Nucl. Phys., A110: 577-84(1968).

Recoilless absorption measurements of the 74.5-keV γ rays of ^{161}Dy were carried out using $Dy(NO_3)_3 \cdot 5H_2O$, $DyF_3 \cdot \frac{1}{2}H_2O$ and $DyNi_2$ absorbers. The analysis of the absorption spectrum obtained with the nitrate absorber yielded a value of 1.38 ± 0.02 for the ratio of the g-factor of the 74.5-keV and the ground levels of ^{161}Dy and a value of 0.58 ± 0.04 for the corresponding ratio of the quadrupole moments. Relying on previous measurements of the ground-state moments, the values derived for the magnetic and quadrupole moments of the 74.5-level are −0.377 ± 0.012 n.m. and 1.5 ± 0.2 b, respectively. These values are compared with the values predicted by nuclear theory. The isomeric shift between $DyNi_2$ and $DyF_3 \cdot \frac{1}{2}H_2O$ absorbers was found to be 0.9 ± 0.2 mm/sec. (auth)

20594 COINCIDENCE MEASUREMENTS ON THE DECAY OF ^{168}Tm(87 day). Kenealy, P. F.; Funk, E. G.; Mihelich, J. W. (Univ. of Notre Dame, Ind.). Contract AT(11-1)-498. Nucl. Phys., A110: 561-78(1968). (COO-498-65).

The decay of ^{168}Tm(87 day) was studied with Ge(Li) detectors in singles and in coincidence with a NaI detector. The energies and intensities of the following previously established transitions were obtained: 79.8, 99.3, 173.8, 184.4, 198.3, 273.0, 348.5, 422.2, 447.6, 546.8, 557.0, 631.7, 645.75, 673.7, 720.4, 730.7, 741.4, 748.25, 816.0, 821.1, 829.9, 914.8, 928.9, 1014.2, 1167.3, 1277.3, 1323.7, 1351.4, and 1461.5 keV. Additional γ-ray transitions at 284.5, 853.2, 1262.6, and 1489.7 keV were observed. These data were combined with the available internal conversion electron data to obtain internal conversion coefficients. Branching ratios for E2 transitions

de-exciting levels in the gamma band and E1 transitions de-exciting the negative-parity states were calculated and compared with theoretical estimates. Prompt and delayed coincidence measurements were carried out using a 2 mm Ge(Li) detector and a 7.6 cm × 7.6 cm NaI detector. Gates were set at 79.8, 99.3, 184.4, 198.3, and 447.6 keV and on transitions in the region from 700 to 850 keV. The delayed coincidence measurements were made to investigate the population and decay of the 0.12 μsec state at 1094.1 keV and support the placement of the 348.5-keV transition in the decay scheme. A revised decay scheme is presented. (auth)

20595 THE NUCLEAR MAGNETIC MOMENT OF ^{117m}In. Mufti, A. R.; Cameron, J. A.; Waddington, J. C.; Summers-Gill, R. G. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 46: 177-81(Feb. 1, 1968).

The hyperfine structure of 1.9-hour ^{117m}In was investigated using atomic magnetic resonance. In the $^2P_{\frac{1}{2}}$ and $^2P_{\frac{3}{2}}$ electronic states, the magnetic dipole interaction constants are $a_{\frac{1}{2}} = -932.996 \pm 0.012$ Mc/s and $a_{\frac{3}{2}} = -99.005 \pm 0.010$ Mc/s. If the possibility of a hyperfine anomaly is neglected, the nuclear magnetic moment of ^{117m}In is -0.25146 ± 0.00003 nm. Thus the nucleus follows the trend shown by other $2p_{\frac{1}{2}}$ proton nuclei, namely that the addition of a neutron pair always reduces the deviation from the Schmidt value. (auth) (CANADA)

20596 THE NUCLEAR SPIN OF ^{155}Sm. Eastwood, H. K.; Summers-Gill, R. G. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 46: 230-2(Feb. 1, 1968).

The nuclear spin of ^{155}Sm was determined to be $I = \frac{3}{2}$, using the atomic-beam magnetic-resonance technique. (D.C.W.)

20597 THE THERMAL NEUTRON CROSS SECTIONS AND RESONANCE INTEGRALS OF ^{50}Cr, ^{109}Ag, ^{123}Sb, ^{133}Cs, ^{191}Ir, AND ^{202}Hg. Sims, G. H. E.; Juhnke, D. G. (Atomic Energy of Canada Ltd., Ottawa). J. Inorg. Nucl. Chem., 30: 349-53(Feb. 1968).

The effective neutron cross sections were measured by the activation method. By irradiating samples with and without cadmium covers, and by assuming a $1/v$ dependence in the subcadmium region, the 2200 m/sec cross sections and resonance integrals were calculated using the Westcott convention. The values for σ_0 are ^{50}Cr 15.9 ± 0.1, ^{109}Ag 4.98 ± 0.47, ^{123}Sb 4.44 ± 0.09, ^{133}Cs 29.2 ± 2.3, ^{191}Ir 1120 ± 25, and ^{202}Hg 4.87 ± 0.05 barns. The resonance integrals (I) are ^{50}Cr 10.4 ± 0.4, ^{109}Ag 81.1 ± 2.2, ^{123}Sb 142.6 ± 4.0, ^{133}Cs 495 ± 17, ^{191}Ir 4800 ± 240, and ^{202}Hg 3.94 ± 0.08 barns. All measurements are relative to a ^{59}Co cross section of 37.5 barns and a ^{59}Co resonance integral of 69.9 barns. (auth) (UK)

20598 SYMMETRIC FISSION OF ^{232}Th BY 14-MeV NEUTRONS. Mo, Tin; Rao, M. N. (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem., 30: 345-7(Feb. 1968).

The fission yields of seven nuclides in 14.8-MeV neutron-induced fission of ^{232}Th, mostly in the symmetric fission region, were determined radiochemically; and the existence of a third peak in this mass-yield curve was confirmed by further evidence. (auth) (UK)

20599 INTERNAL PAIR FORMATION IN THE ELECTRIC DIPOLE TRANSITIONS OF THE ISOTOPE ^{144}Nd. Brunner, J. H. (Laboratoire de Physique des Hautes Energies, Zurich). Helv. Phys. Acta, 41: 121-50(Apr. 1, 1968). (In French).

The internal pair formation in the 1.49- and the 2.18-MeV electric dipole transitions in ^{144}Nd was studied theoretically and experimentally. The positron spectra were calculated using solutions of the Dirac equation for a point nucleus as electronic wave functions. The influence of the screening due to the atomic electrons was evaluated by multiplying the Coulomb potential with a function of the type $\phi(r) = 1 - ar$. This correction results in a small translation of the spectra towards lower energies. The internal pair formation coefficients are $\alpha_\pi(1.49) = 2.05 \times 10^{-4}$ and $\alpha_\pi(2.18) = 6.91 \times 10^{-4}$, respectively. The positron spectra of the same transitions were measured with the help of a long-lense magnetic spectrometer with improved electron-positron separation, using a special detector. Both spectra have been separated on the basis of their theoretical shape. No experimental evidence was found of the screening effects. From the comparison with a β^- spectrum in the same source, the experimental value of the internal pair formation coefficients turn out to be $\alpha_\pi(1.49) = 1.9 \pm 0.8 \times 10^{-4}$ and $\alpha_\pi(2.18) = 6.7 \pm 1.0 \times 10^{-4}$. According to the agreement between the predicted and the experimental shape of the upper spectrum, it is concluded that the internal pair formation in the corresponding transition is fairly well described by the point nucleus approximation. There is no evidence of nuclear structure effects within the limits of error. (auth)

20600 HALF-LIFE OF THE 53-keV LEVEL IN ^{197}Pt. Malmskog, S. G. (Aktiebolaget Atomenergi, Studsvik, Sweden). Ark. Fys., 34: 195-8(1967).

The half-life of the recently proposed 53-keV level in ^{197}Pt was measured to 18.5 ± 1.5 nsec using the delayed coincidence technique. This level, which was identified with the $f_{\frac{7}{2}}$ single-particle state, decays directly to the $p_{\frac{3}{2}}$ ground state in ^{197}Pt. The reduced E2 transition probability for this 53-keV transition was deduced and was compared with the results obtained for the corresponding transition in other Pt, Hg, and Pb isotopes and with the theoretical predictions by Sorensen and by Wahlborn and Martinson. (auth) (Sweden)

20601 INFLUENCE OF POSITRON ANNIHILATION IN γ–γ COINCIDENCE MEASUREMENTS IN THE DECAY OF ^{119}Te AND ^{119m}Te. Svensson, Aa. G.; Norlin, L. O.; Tandon, P. N. (Univ. of Uppsala). Ark. Fys., 34: 113-19(1967).

A qualitative experimental investigation of the influence of the annihilation radiation in angular correlation measurements is reported, where the annihilation in flight was considered. It was shown that in the present source, annihilation contributions were of two kinds. One was caused by a summing up effect and the other was due to detection of annihilation in flight quanta. Some general remarks about the influence of annihilation in a conventional angular correlation geometry are given. (auth) (Sweden)

20602 ON THE $d_{\frac{5}{2}} \rightleftharpoons g_{\frac{7}{2}}$ TRANSITIONS IN ODD-MASS Pm NUCLEI. Baecklin, A. (Univ. of Uppsala. Forskningsradens Laboratorium, Studsvik, Sweden). Malmskog, S. G. Ark. Fys., 34: 531-7(1967).

The half-lives of the first excited levels in ^{145}Pm and ^{147}Pm were measured by the delayed coincidence method and are 2.69 + 0.08 nsec and 2.51 + 0.05 nsec, respectively. From a measurement of the L subshell ratios of the 61-keV transition in ^{145}Pm, an E2 admixture of 0.15 + 0.05% was obtained. The transition energy was found to be 61.25 + 0.05 keV. The experimental reduced E2 transition probabilities from the first excited states to the ground states of ^{145}Pm, ^{147}Pm, and ^{149}Pm were compared to the theoretical predictions of Sorensen. (auth) (Sweden)

20603 NUCLEAR MAGNETIC MOMENT OF THE 3.2-MeV STATE IN ^{209}Pb. Johansson, K.; Gustavsson, S.; Svensson, Aa. G. (Univ. of Uppsala). Ark. Fys., 34: 97-107(1967).

The nuclear magnetic moment of the 3.2-MeV 5^- state in ^{209}Pb was measured using the perturbed angular correlation method. An automatic apparatus for measurements of unperturbed angular correlations is described and explicit for the correction of competing cascades are given. The magnetic moment was found to be zero within limits of error. The corresponding theoretical value was calculated in the Tamm-Dancoff approximation using the single-particle operators. The agreement between experiment and theory is satisfactory. (auth) (Sweden)

20604 DECAY OF THE 205-keV LEVEL IN ^{205}Tl. Malmskog, S. G. (Aktiebolaget Atomenergi, Studsvik, Sweden). Ark. Fys., 34: 109-12(1967).

The half-life of the first excited state in ^{205}Tl, obtained from the decay of the 5.2-min ^{205}Hg isotope, was measured using the delayed coincidence method. The half-life of the 205-keV level in ^{205}Tl was measured to be 1.5 + 0.1 nsec. The experimental result was compared with recent calculations by Sorensen and by Wahlborn and Martinson. (auth) (Sweden)

20605 TRANSITIONS, LIFETIMES, AND LEVELS IN ^{149}Pm. Baecklin, A. (Univ. of Uppsala, Forskningsradens Laboratorium, Studsvik, Sweden); Solhed, H.; Malmskog, S. G. Ark. Fys., 34: 495-529(1967).

Transitions and levels in ^{149}Pm were studied from the beta decay of ^{149}Nd. The internal conversion spectrum was measured with a double-focusing beta spectrometer, and the half-lives of 7 levels were studied with the delayed coincidence technique. Around 70 conversion lines belonging to 35 transitions were recorded. The energies of the strongest lines were measured with an accuracy of a few parts in 10^4. Previously unreported transitions were found at 117.06 (M1 + 25 percent E2) and 273.1 keV; and the earlier reported 74-keV transition was resolved into three components with energies of 74.32, 74.66, and 75.74 keV. Multipolarities and mixing ratios were determined for around 35 transitions, of which the most important are: 30.00 (E2), 74.32 (M1 + 33 percent E2), 97.03 (M1), 114.32 (M1 + 2.7 percent E2), 115.87 (E1), 188.62 (E2), 198.93 (M1), 211.28 (M1 + 14 percent E2), 240.20 (M2), 267.65 (M1), 270.12 (E1), 326.45 (E1), 349.26 (E1), 423.54 (E1), 540.6 (E1), and 654.4 (E1), where the energies were given in keV. The half-life was measured for the following levels, for which the spin and parity suggested by the multipolarities are given in parenthesis: 114.32 ($\frac{5}{2}^+$) 2.58 nsec, 188.64 ($\frac{5}{2}^+$) 3.24 nsec, 211.32 ($\frac{5}{2}^+$) 80 psec, 240.20 ($\frac{11}{2}^-$) 35 μsec, 270.18 ($\frac{7}{2}^-$) 2.64 nsec, 387.57 ($\frac{7}{2}^+$) 0.6 nsec, and 537.82 ($\frac{9}{2}^-$) 50 psec. Reduced transition probabilities were calculated for a number of transitions. Three E2 transitions were enhanced around a factor of 50 over the single particle estimate. The E1

transitions from the 270-keV level were retarded around a factor 10^5. The levels are discussed in terms of the model with weak coupling between a particle and a surface vibration. The levels at 538 and 654 keV are tentatively suggested to be deformed states. (auth) (Sweden)

20606 ON THE PROPERTIES OF THE $S_{\frac{1}{2}} \rightarrow d_{\frac{3}{2}}$ TRANSITION IN ^{199}Au. Baecklin, A. (Univ. of Uppsala. Forskningsradens Laboratorium, Studsvik, Sweden); Malmskog, S. G. Ark. Fys., 34: 59-70(1967).

The half-life of the 77-keV level in ^{199}Au was measured by the delayed coincidence method. The energy E2/M1 mixing ratio of the de-exciting transition was determined by measuring the internal conversion L lines in a focusing spectrometer. The L lines of the 77-keV transition in ^{197}Au were also measured. The resulting M1 and E2 transition probabilities of these 1-forbidden transitions were compared with those of the corresponding transitions in neighbouring Au, Ir, and Tl isotopes. These experimental data were compared with the predictions of the core excitation model and the calculations by Kisslinger and Sorensen where residual interactions were taken into account. (auth) (Sweden)

20607 HEXADECAPOLE EQUILIBRIUM DISTORTIONS OF NUCLEI. Moller, P. (Lund Inst. of Tech., Sweden); Nilsson, B.; Nilsson, S. G.; Sobiczewski, A.; Szymanski, Z.; Wycech, S. Phys. Lett., 26B: 418-20(Mar. 4, 1968).

Theoretical calculations of nuclear deformed shell model equilibrium shapes in the rare-earth and actinide regions have yielded hexadecapole distortions in good agreement with recent experimental shapes determined from (α,α') scattering analysis. Pairing, Coulomb and polarization effects are included in the calculations. (auth)

20608 SPINS AND ATTENUATION COEFFICIENTS OF THE 86.5- AND 105.3-keV STATES IN ^{155}Gd. Soinski, A. J.; Karlsson, E.; Shirley, D. A. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Lett., 26B: 440-2(Mar. 4, 1968). (UCRL-17970).

Nuclear orientation was used to determine the spins of the 86.5- and 105.3-keV states in ^{156}Gd as $\frac{5}{2}$ and $\frac{3}{2}$, respectively. Derived values for the attenuation coefficients showed that the orientation is strongly perturbed in the 86.5-keV state. (auth)

20609 NEUTRON PARTICLE-HOLE STRUCTURE OF ^{208}Pb FROM (d,p) EXCITATION FUNCTIONS. Dost, M.; Hering, W. R. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett., 26B: 443-5(Mar. 4, 1968).

Excitation functions from 7 to 11 MeV of the (d,p) reaction on ^{207}Pb are studied. From their respective slopes the transferred orbital angular momenta are determined. The spectroscopic factors give a consistent picture of the distribution of particle-hole configurations over many states in ^{208}Pb. Model-independent particle reduced widths are derived from the measurements. (auth)

20610 CHARGE EXCHANGE IN ^{91}Zr(p,d)^{90}Zr. Michelman, L. S.; Moore, C. F. (Univ. of Texas, Austin). Contract AT(40-1)-2972. Phys. Lett., 26B: 446-7(Mar. 4, 1968). (ORO-2972-57).

The excitation function for the reaction ^{91}Zr(p,d)^{90}Zr was measured in the energy region near the threshold of the quasi-elastic ^{91}Zr(p,n)^{91}Nb^{A} reaction. The deuteron excitation function exhibits a change in the slope of the cross section at this threshold which is attributed to isospin coupling. (auth)

20611 IDENTIFICATION OF 1^- NEUTRON PARTICLE-HOLE STATES IN ^{140}Ce. Von Brentano, P.; Braithwaite, W. J.; Cramer, J. G.; Eidson, W. W.; Phillips, G. W. (Univ. of Washington, Seattle). Phys. Lett., 26B: 448-50(Mar. 4, 1968).

The γ-ray decay of neutron particle-hole states in ^{140}Ce was studied with the reaction ^{140}Ce(p,p'γ_0)^{140}Ce. Evidence is presented that the strong ground-state γ rays observed from some of these states are E1 transitions. This allows the identification of 1^- states. (auth)

20612 DEUTERON POLARIZABILITY IN ELASTIC SCATTERING AROUND 2 MeV. Deconninck, G.; Demortier, G. (Univ., Louvain). J. Phys. (Paris), 29: 19-21(Jan. 1968). (In French).

The polarizability of the deuteron is responsible for a very small effect in elastic scattering of deuterons on nuclei. This effect is discussed; and a very sensitive method of measurement, which removes most of the experimental uncertainties, is described in detail. A discrepancy between theory and experiment appears in experimental results. (auth)

20613 EXCITED STATES IN ^{111}Cd. McDonald, J.; Porter, D. (Univ. of Glasgow). Nucl. Phys., A109: 529-38(1968).

The energy levels in ^{111}Cd were investigated by Coulomb excitation using He ions and from the β decay of ^{111}Ag. The half-life of the 246-keV level was redetermined by the $\beta\gamma$-delayed coincidence method. Gamma-ray energies and intensities were measured using Ge(Li) detectors and B(E2) values deduced for levels at 246, 342, and 620 keV and for a new level at 755 keV. The energy of the 620-keV level is substantially higher than that previously accepted. Five new transitions have been found, and partial half-lives for 13 gamma rays are tabulated. Transition probabilities are discussed in terms of the core excitation and the pairing-plus-quadrupole-force models. (auth)

20614 THE REACTIONS ^{203,205}Tl$(\alpha,t)^{204,206}$Pb. Nathan, O.; Bruge, G.; Bussiere, A.; Kossanyi, P.; Loiseaux, J. M.; Roussel, P.; Testoni, J.; Valentin, L. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., A109: 481-8(1968).

The reactions ^{203}Tl$(\alpha,t)^{204}$Pb and ^{205}Tl$(\alpha,t)^{206}$Pb were investigated at an incident energy of 44 MeV, the reaction products being momentum analyzed in a double $\Delta E + E$ particle identification system with semiconductor counters. The resulting energy resolution was 120 keV. Transitions were observed to the ground state and the lowest 2^+ states of ^{204}Pb and ^{206}Pb and to a number of states at higher excitation energies, starting at about 2.9 MeV in ^{204}Pb and about 2.6 MeV in ^{206}Pb. Angular distributions were measured for the triton groups corresponding to the ground and first excited states of ^{204}Pb. The distributions have a forward peaked shape which can be reproduced well by a DWBA calculation assuming a simple proton stripping process. (auth)

20615 STATISTICAL REACTIONS IN FISSIONING NUCLEI. II. FISSION ISOMERS POPULATED IN (n,γ) REACTION. Jagare, S. (NORDITA, Copenhagen). Nucl. Phys., A109: 633-40(1968).

The spin-dependent statistical model for x$n\gamma$ reactions in fissioning nuclei given in a previous paper is extended to (n,γ) reactions. The most probable spin values deduced for the fission isomer in ^{242}Am are in agreement with those obtained earlier. (auth)

20616 CONVERSION ELECTRON SPECTRUM EMITTED DURING THE DECAY OF ^{169}Er INTO ^{169}Tm. Marques, Maria-Ines; Ramos, Maria Teresa (CNRS, Orsay, France. Institut Joliot-Curie, Orsay, France). Compt. Rend., Ser. A and B, 265: 1209-12(Nov. 20, 1967). (In French).

The internal conversion spectrum emitted during the decay ^{169}Er $\rightarrow$ ^{169}Tm was studied with a semicircular spectrometer. The conversion rays in the subshells of the M, N, and O levels were observed. From the ratio M_I/M_{II} the degree of mixing $E2/M1 = 0.9 \pm 0.1 \times 10^{-3}$ was deduced. (tr-auth)

20617 NEUTRON-INDUCED (n,α) REACTIONS ON ^{103}Rh AND INDIUM AT E_n = 14 MeV. Veselic, D.; Tudoric-Ghemo, J. (Inst. Ruder Boskovic, Zagreb). Nucl. Phys., A110: 225-32(1968).

Energy and angular distributions from the ^{103}Rh(n,α) and ^{115}In(n,α) reactions were measured. The spectrum from ^{115}In was observed at 0° only. The spectrum of alpha particles from ^{103}Rh was interpreted as a statistical one with a remarkable structure due to the presence of a direct process. The alpha energy spectrum from indium is explained in terms of a direct process only. In both cases the structure of energy spectra is in a certain correspondence with the calculated single-neutron level density of the residual nuclei. The probabilities of alpha clustering on the surface of the target nuclei have been estimated assuming the n-α knock-out mechanism for the direct process observed. (auth)

20618 ENERGY LEVELS OF ^{210}Po POPULATED BY THE DECAY OF ^{210}At. Prussin, S. G.; Hollander, J. M. (Univ. of California, Berkeley). Nucl. Phys., A110: 176-92(1968). (UCRL-17843).

The electron-capture decay of 8.3 h ^{210}At to levels in ^{210}Po was studied with high-resolution Ge and Si spectrometers and an anti-Compton Ge spectrometer. Fifty transitions among levels in ^{210}Po were observed, and the K-conversion coefficients of nine of these were measured with a solid-state conversion-coefficient spectrometer. The new data account for most of the weak, unassigned conversion-electron lines reported in previous studies. A decay scheme is presented that incorporates forty transitions, and the ^{210}Po levels are discussed in terms of recent theoretical calculations. (auth)

20619 ENERGY SPECTRA OF ALPHA PARTICLES FROM THE ^{122}Te(n,α)^{119}Sn, ^{159}Tb(n,α)^{156}Eu AND ^{169}Tm(n,α)^{166}Ho REACTIONS WITH 14.2 MeV NEUTRONS. Jaskola, M.; Osakiewicz, W.; Turkiewicz, J.; Wilhelmi, Z. (Inst. of Nuclear Research, Warsaw. Warsaw Univ.). Nucl. Phys., A110: 11-16(1968).

The energy spectra of alpha particles from the ^{122}Te(n,α)^{119}Sn, ^{159}Tb(n,α)^{156}Eu, and ^{169}Tm(n,α)^{166}Ho reactions at 14.2 MeV were studied using the semiconductor detector technique. The analysis of the energy spectra leads to results that the evaporation theory is inadequate to describe the investigated reactions. The shapes of the

experimental spectra suggest the presence of strong direct effects. (auth)

20620 THE REACTIONS ^{116,118}Sn(t,p)^{118,120}Sn. Bjerregaard, J. H. (Univ. of Copenhagen); Hansen, O.; Nathan, O.; Vistisen, L.; Chapman, R.; Hinds, S. Nucl. Phys., A110: 1-10(1968).

The ^{116}Sn(t,p) and ^{118}Sn(t,p) reactions were investigated at bombarding energies of 13 and 12 MeV, respectively. The reaction protons were detected at 24 angles between 5 and 175° with an overall energy resolution of 15 to 20 keV. The proton spectra were dominated by the intense ground-state transitions, but several groups leading to excited states (below E_x = 4 MeV) were also identified. The angular distribution systematics is discussed and the (t,p) intensities are compared to qualitative predictions based on the pair-coupling scheme. (auth)

20621 SEARCH FOR SHORT-LIVED ISOMER OF ^{204}Tl. Horrocks, Donald L. (Argonne National Lab., Ill.). Nucl. Phys., A110: 238-40(1968).

After 9.4 y observation, the best half-life for ^{204}Tl is 3.825 ± 0.003 y. No evidence of a short-lived (about 2.5 y) isomer of ^{204}Tl has been found. (auth)

20622 MEASUREMENT OF X RAYS AS A FUNCTION OF MASS IN THE THERMAL FISSION OF ^{235}U. Bohn, E. M.; Wehring, B. W.; Wyman, M. E. (Univ. of Illinois, Urbana). Appl. Phys. Lett., 12: 199-201(Mar. 1, 1968).

Characteristic K x rays from thermal neutron fission of ^{235}U were studied as a function of the fission-fragment mass. With a NaI(Tl) detector viewing the first 1 cm of fragment paths, x rays in coincidence with fission were recorded together with the fragment energies as detected by silicon surface-barrier detectors. Results are reported for yields of K x rays as a function of fragment mass. The most probable charge for various masses is estimated. (auth)

20623 SPECTROSCOPY OF ^{208}Pb AND ^{207}Pb BY INELASTIC SCATTERING OF 24.5 MeV PROTONS. Saudinos, J.; Vallois, G.; Beer, O.; Gendrot, M.; Lopato, P. (CEN, Saclay, France). pp 67-71 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Inelastic proton scattering by ^{208}Pb shows a 2^+, 4^+, 6^+, 8^+ level sequence in this nucleus. Some unnatural-parity levels are also analyzed. The splitting of the 3^-, 2^+, and 6^+ ^{208}Pb states is observed in ^{207}Pb. Other levels are analyzed in ^{207}Pb. (auth)

20624 EXPERIMENTAL STUDY OF NEUTRON STATES IN ^{181}Hf, ^{173}Yb, AND ^{175}Yb. Gastebois, J.; Barloutaud, M.; Laget, J. M. (CEN, Saclay, France). pp 108-11 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Experimental results of (d,p) reactions at 12-MeV incident energy, on ^{180}Hf, ^{172}Yb, and ^{174}Yb targets are presented. Preliminary calculations show the influence of band mixing and pairing effects on the calculated cross sections. (auth)

20625 THEORETICAL PREDICTION AND EXPERIMENTAL OBSERVATION OF THE J DEPENDENCE IN (d,^{3}He) REACTIONS. Newman, E. (Oak Ridge National Lab., Tenn.); Preedom, B. M.; Heibert, J. C. pp 116-20 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The J dependence of the angular distributions of the $\frac{1}{2}^-$ ground and $\frac{3}{2}^-$ second excited states in the ^{90}Zr(d,^{3}He)^{89}Y reaction observed at 34.4 MeV. Local zero range distorted-wave calculations reproduce the observed effect quantitatively. It is shown that a spin-orbit interaction in the deuteron channel is responsible for the theoretical prediction of the effect and that spin-orbit interactions in the bound state function and the ^{3}He channel have little effect. (auth)

20626 THE NEUTRON POTENTIAL FOR A = 208 DETERMINED FROM COULOMB STRIPPING AND LEVEL ENERGIES IN LEAD. Smith, W. R. (Oxford Univ.); Dost, M.; Hering, W. R. pp 126-8 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The Woods–Saxon neutron potential was determined for the best simultaneous explanation of the levels in ^{207}Pb and ^{209}Pb and the ^{208}Pb(d,p)^{209}Pb cross sections at 8 MeV. It has a radius R = 1.248 $A^{\frac{1}{3}}$ F, diffuseness a = 0.633 F, spin-orbit depth V_{so} = 7.07 MeV, and nonlocality length β = 0 F. This β = 0 F indicates a possible breakdown of the local energy approximation for the tails of bound-state wave functions. (auth)

20627 SINGLE QUASIPARTICLE AND COLLECTIVE STATES IN THE ODD ISOTOPES OF TIN. Cavanagh, P. E.; Coleman, C. F.; Hardacre, A. G.; Turner, J. F. (Atomic Energy Research Establishment, Harwell, Eng.). pp 129-32 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The energy levels of the odd tin isotopes from mass numbers 111 to 123 were investigated using the (p,d) reaction at 30 MeV. The cross sections for excitation of $g_{\frac{7}{2}}$, $d_{\frac{5}{2}}$, $s_{\frac{1}{2}}$, $d_{\frac{3}{2}}$, and $h_{\frac{11}{2}}$ levels are all shown to vary smoothly with mass numbers. Levels with l = 0 and l = 1 appear at 2 to 3 MeV excitation, which are possibly collective in character. (auth)

20628 ISOBARIC ANALOG STATES IN ^{116}Sn, ^{122}Sn, AND ^{124}Sn. Schneid, E. J.; Hamburger, E. W. (Univ. of Pittsburgh). pp 214-17 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The isobaric analog of the $\frac{1}{2}^+$ and $\frac{3}{2}^+$ single-particle states of ^{117}Sn, ^{123}Sn, and ^{125}Sn were studied using inelastic proton scattering. Partial widths (Γ_p) were obtained and were compared with theoretically predicted partial widths. The collective 3^- state does not appear to resonate strongly at either of the isobaric analog states studied. (auth)

20629 SPIN DETERMINATION OF ISOBARIC ANALOG STATES FROM POLARIZATION MEASUREMENTS. Fiarman, S.; Ludwig, E. J.; Michelman, L.; Robbins, A. B. (Rutgers-The State Univ., New Brunswick, N. J.). pp 218-22 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Measurements were made on the polarization of protons elastically scattered from analog state resonances in ^{91}Nb, ^{145}Eu, and ^{209}Bi. From comparison with the theoretical predictions of Adams, Thompson, and Robson, spin assignments were made to the corresponding isobaric multiplets. These assignments are $d_{\frac{5}{2}}$ for ^{91}Zr (2.06 MeV), $f_{\frac{7}{2}}$ for ^{145}Sm (g.s.), $p_{\frac{1}{2}}$ for ^{145}Sm(0.90 MeV), and $g_{\frac{9}{2}}$ for ^{209}Pb (g.s.). (auth)

20630 ISOTOPE SHIFT IN THE COULOMB DISPLACEMENT ENERGIES OF THE LEAD ISOTOPES. Temmer, G. M. (Rutgers-The State Univ., New Brunswick, N. J.). pp 223-7 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The isotope effect in the Coulomb displacement energies of the lead-bismuth analog doublets obtained from resonant proton scattering on all stable lead isotopes is discussed and is compared with the $A^{-\frac{1}{3}}$ variation expected on the simple uniform charge model as well as with purely electrostatic measurements of the mean charge radius from optical HFS and μ-mesic x rays. (auth)

20631 NUCLEAR STRUCTURE VIA ANALOG STATES. Moore, C. Fred; Zaidi, S. A. A.; Parish, Leslie; von Brentano, P. (Univ. of Texas, Austin). pp 229-32 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Proton elastic and inelastic excitation curves were measured on ^{208}Pb. All the states in ^{209}Bi* which are analogs of the strong single-particle states in ^{209}Pb are observed. The measured yield to the 5^- and 4^- states in ^{209}Pb is used as an example to show how the analog resonances can be used to obtain information concerning the structure of excited states. (auth)

20632 PROTON DECAY OF ISOBARIC ANALOG RESONANCES IN ^{141}Pr TO PARTICLE-HOLE STATES IN ^{140}Ce. Wurm, J. P.; von Brentano, P.; Mudersbach, K. (Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 252-4 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

An experiment on the proton decay of the first two isobaric analog resonances in ^{141}Pr is reported. Strong transitions to states in ^{140}Ce at an excitation energy E_x = 4 MeV were found, and these states were identified as neutron-neutron hole configurations. (auth)

20633 ISOBARIC ANALOG STATES OF ^{205}Pb, ^{207}Pb, AND ^{209}Pb. Temmer, G. M. (Rutgers-The State Univ., New Brunswick, N. J.); Lenz, G. H.; Garvey, G. T. pp 255-8 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Elastic and inelastic scattering of protons on ^{204}Pb has revealed

analog states of ^{205}Pb in ^{205}Bi, as well as several new states in ^{204}Pb. Similarities in the excitation of the 2^+ states in ^{204}Pb and ^{206}Pb are noted, including the major role played by Coulomb excitation. Partial proton widths are extracted for the 0^+ analog state of ^{209}Pb and are compared with expectations based on the special nature of this state. (auth)

20634 ISOBARIC ANALOG RESONANCES IN A DEUTERON STRIPPING REACTION. Hamburger, Ernst W. (Univ. of Pittsburgh). pp 259-60 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Isobaric analog resonances were observed in the ^{207}(d,p)^{208}Pb ground-state reaction at $E_D \simeq 11.5$, 11.9, and 12.5 MeV, corresponding to the $d_{\frac{3}{2}}$, $s_{\frac{1}{2}}$, and $d_{\frac{5}{2}}$–$g_{\frac{9}{2}}$ (unresolved) states of ^{209}Pb. The resonances are large, although their formation by deuteron bombardment is isospin forbidden. At 150°, the peak is 50% higher than the nonresonant cross section. (auth)

20635 EXCITATION OF COLLECTIVE OCTUPOLE STATES IN ^{206}Pb, ^{207}Pb, ^{208}Pb, AND ^{209}Bi BY INELASTIC ELECTRON SCATTERING. Ziegler, J. F.; Peterson, G. A. (Yale Univ., New Haven). pp 319-23 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Electrons of 28 to 70 MeV were used to excite collective octupole states at about 2.6 MeV in ^{206}Pb, ^{207}Pb, ^{208}Pb, and ^{209}Bi. Summed reduced nuclear transition probabilities of about 3% accuracy, obtained from a detailed Coulomb-distorted-wave analysis, were approximately equal for all isotopes and were tested to be model independent to 1.5%. There were no free parameters in the analysis. (auth)

20636 THE COLLECTIVE LEVELS IN ^{121}Sb AND ^{123}Sb. Joshi, M. C.; Herskind, B. (Niels Bohr Inst., Copenhagen). pp 357-61 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The nuclear levels in ^{121}Sb and ^{123}Sb were studied by Coulomb excitation with 45-MeV ^{16}O ions and by inelastic scattering of 12-MeV deuterons. The deuterons from the targets were analyzed in a heavy-particle spectrograph. The character of the levels is determined from the measured B(E2) ↑ and σ(d,d′) in comparison with the same quantities for the 2^+ and 3^- levels of ^{120}Sn and ^{122}Sn. (auth)

20637 PARTICLE-CORE INTERACTIONS IN ^{121}Sb and ^{123}Sb. Barnes, P. D.; Ellegaard, C. (Niels Bohr Inst., Copenhagen). pp 363-6 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

An analysis of the level structure of ^{121}Sb and ^{123}Sb observed with the reactions (^{3}He,d), (d,d′), and (^{16}O,^{16}O′γ) has indicated significant coupling of the odd proton to the single closed shell core. A shell-model calculation with a pairing plus quadrupole-quadrupole residual interaction which qualitatively reproduces the level structure at low energies is reported. (auth)

20638 THE g-FACTOR OF THE SECOND 2^+ STATE AT 633-keV IN ^{188}Os. Agarwal, Y. K.; Baba, C. V. K.; Bhattacherjee, S. K. (Tata Inst. of Fundamental Research, Bombay). pp 390-2 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The g-factor of the second 2^+ state at 633 keV ($T_{\frac{1}{2}} = 8.3 \pm 2.5$ psec) in ^{188}Os was measured employing the 828- to 633-keV gamma-gamma cascade. The hyperfine field present at the osmium nuclei in a dilute alloy of rhenium in iron (source activity: 18-hr ^{188}Re) was utilized in this perturbed angular correlation measurement ($H_{hf} = 1400$ kOe). The value of the g-factor was found to be $g = 0.12 \pm 0.04$, a value substantially lower than values obtained by others for the g-factor of first 2^+ state at 155 keV in ^{188}Os. (auth)

20639 LIFETIME DETERMINATION OF THE 1902-keV 0^+ LEVEL IN THE CLOSED NEUTRON SHELL NUCLEUS ^{140}Ce. Burde, J.; Engler, G.; Molchadzki, A.; Ginsburg, A.; Unna, I. (Hebrew Univ., Jerusalem). pp 393-6 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The half-life of the 1902-keV 0^+ level in ^{140}Ce was determined to be $2.7 \pm 0.5 \times 10^{-10}$ sec by (β,e$^-$) coincidence time delay measurements. An upper limit of $T_{\frac{1}{2}} < 10^{-10}$ sec was placed on the intermediate 2520-keV state. The de-excitation of the level is discussed in terms of the pairing correlation model. (auth)

20640 MEASUREMENT AND ANALYSIS OF MUONIC X-RAY SPECTRA IN DEFORMED NUCLEI. De Witt, S. A. (CERN, Geneva); Backenstoss, G.; Daum, C.; Sens, J. C.; Acker, H. L. pp 460-4 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Muonic x-ray spectra were measured in Eu, Hf, Ho, Ir, Os, Pu, Sm, Ta, Tb, Th, W, ^{233}U, ^{235}U, and ^{238}U by stopping negative muons in targets of thicknesses ranging from 2 to 13 g/cm^2 and observing the x- rays emitted with a Ge(Li) detector. The data were analyzed considering two models for the nuclear charge distribution. Both models are extensions to nonspherical nuclei of the Fermi-type charge distribution. (D.C.W.)

20641 FOUR-QUASI PARTICLE EXCITATIONS AND EVEN-PARITY STATES OF EVEN TIN ISOTOPES. Ottaviani, P. L. (Univ., Bologna); Savoia, M.; Sawicki, J.; Tomasini, A. pp 566-8 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The quasiparticle second Tamm-Dancoff (QSTD) approximation is developed and is applied to the study of the 2^+, 4^+, and 0^+ states of even tin isotopes. The spurious kets due to the particle number nonconservation are projected out. The single nucleon energies and radial wave functions for the five neutron subshells are of a Saxon–Woods potential and a harmonic oscillator potential. A zero-range spin-dependent two-nucleon force is employed. Good agreement with the 2^+ and 4^+ data is obtained. The simple QTD (QRPA) method and the naive two-phonon model are criticized. (auth)

20642 TRANSITION STATE IN NUCLEAR FISSION. Huizenga, J. R. (Argonne National Lab., Ill.). pp 721-34 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

A survey of experimental and theoretical observations on the transition state in fission is presented. Fission-fragment angular distributions for several types of nuclear reactions are discussed together with the information about transition spectra which can be extracted from such experiments. (D.C.W.)

20643 ANISOTROPY AND KINETIC ENERGY IN THE REACTIONS ^{235}U(d,pf) AND ^{239}Pu(d,pf). Specht, H. J.; Fraser, J. S.; Milton, J. C. D. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 737-41 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Measurements of the fragment angular anisotropy [W(0°)/W(90°)] and the total kinetic energy of fission were made for the reactions ^{235}U(d,pf) and ^{239}Pu(d,pf). In the region of the fission threshold, an anisotropy of ~0.5 was found for ^{235}U(d,pf), compared to ~4 for ^{239}Pu(d,pf). The kinetic energy decreases smoothly with increasing excitation energy for both nuclei. (auth)

20644 SPONTANEOUSLY FISSIONING ISOMERS. Malov, L. A.; Polikanov, S. M.; Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 786-8 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

It is stated that the previously discovered spontaneously fissioning isomers are excited two-quasi-particle states in odd-odd nuclei with $K^\pi = 12 - (p_{\frac{11}{2}} - [505]\ n_{\frac{13}{2}} + [606])$ and $K^\pi = 11 - (p_{\frac{11}{2}} - [505]\ n_{\frac{13}{2}} + [615])$ which have equilibrium deformations of the order of 0.32 and an excitation energy of 1 to 1.5 MeV. The partial lifetimes are estimated for spontaneous fission and alpha and gamma transitions. Those nuclei which are most likely to have spontaneously fissioning isomers are indicated. (auth)

20645 ANISOTROPY OF CONVERSION ELECTRONS IN (p,2n) REACTIONS. Ejiri, H. (Tokyo Univ.); Ihsihara, M.; Sakai, M.; Inamura, T.; Katori, K. pp 819-22 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The anisotropy of conversion electrons from collective states excited by (p,2n) reactions was studied experimentally and theoretically. The observed anisotropy showed systematic dependence on the spins of the target and the excited levels associated with the transition and the multipolarity. The analysis of the anisotropy in

the framework of the statistical continuum theory predicted well the general features of the experiments. (auth)

20646 ISOTOPES SEPARATOR ON-LINE STUDIES OF SHORT-LIVED NUCLEI. Holm, G. B.; Borg, S.; Fagerquist, U. (Research Inst. of National Defence, Stockholm. Research Inst. for Physics, Stockholm). pp 887-9 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

With the intention of eventually reaching nuclei far off the stability line, experiments have been started using continuous production, isotope separation, and detection for the study of fission products. The shortest half-life observed so far is 10 sec, but work is in progress to install an isotope separator close to a reactor. Results have been obtained on semiclosed shell and neighboring nuclei. (auth)

20647 SPECTROSCOPIC STUDY OF THE γ VIBRATION IN DEFORMED EVEN NUCLEI POPULATED IN THE (d,p) REACTION. Kern, Jean (Univ., Fribourg, Switzerland); Mikoshiba, Osamu; Sheline, Raymond K.; Udagawa, Takeshi; Yoshida, Shiro. pp 890-3 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

On the basis of the DWBA theory and the current microscopic vibrational nuclear model, the deuteron stripping reaction cross sections for the excitations of the various rotational states in the γ-vibrational bands are calculated for the even deformed nuclei in the rare-earth region. The results are also compared with experiment. (auth)

20648 THE LEVEL STRUCTURE OF ^{125}I. Geiger, J. S.; Graham, R. L. (Atomic Energy of Canada Ltd., Chalk River, Ontario). pp 916-18 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

The gamma-ray spectrum of 17-hr ^{125}Xe was measured with Ge(Li) detectors. NaI(Tl) detectors were used for studying gamma-gamma coincidences. Combined with previous knowledge, the new results indicate levels in ^{125}I at 0 keV, $\frac{5}{2}^+$; 113.57 keV, $\frac{7}{2}^+$; 188.43 keV, $\frac{3}{2}^+$; 243.40 keV, $\frac{1}{2}^+$; 372.08 keV, $^+$; 453.83 keV, $^+$; 1007.6 keV, 1089.8 keV, 1180.9 keV, 1264.6 keV, 1383 keV, 1442.8 keV, and 1562 keV. There are weak positron decay branches to the 188.43- and 243.40-keV levels. (auth)

20649 COLLECTIVE STATES OF ODD-MASS DEFORMED NUCLEI IN THE RARE-EARTH REGION. Solov'ev, V. G.; Vogel, P. (Joint Inst. of Nuclear Research, Dubna, USSR). pp 541-3 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

The interactions of quasiparticles with quadrupole and octupole phonons in deformed odd-mass nuclei ($153 \leq A \leq 187$) are considered in the framework of the method of approximate second quantization. This interaction leads to the formation of the collective nonrotational states and of the complex structure states. The calculated excitation energies, the E2 transition probabilities, and the values of the decoupling parameter α are in satisfactory agreement with the corresponding experimental data. (auth)

20650 KeV-NEUTRON SCATTERING BY LEAD AND THE NEUTRON ELECTRIC POLARIZABILITY. Aleksandrov, Yu. A.; Samosvat, G. S.; Sereeter, J.; Tsoy Gen Sor (Joint Inst. for Nuclear Research, Moscow). pp 378-81 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

Precision measurements of the angular distributions of neutron scattering by lead were carried out in the interval of angles 30 to 50° and energy range up to 25 keV. An analysis of the results shows that the value of the neutron electric polarizability α_n is within the limits of -4.7×10^{-42} cm$^3 < \alpha_n < 6.1 \times 10^{-42}$ cm^3. (auth)

20651 E0 ADMIXTURES IN ΔI = 0 TRANSITIONS BETWEEN K = 0 VIBRATIONAL AND ROTATIONAL BANDS. Hamilton, J. H. (Vanderbilt Univ., Nashville); Riedinger, L. L.; Johnson, Noah R. pp 919-21 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

Large E0 admixtures were measured in four ΔI = 0 transitions between K = 0 bands in ^{154}Gd and ^{152}Sm. The ratio of E0 to E2 conversion was obtained from gamma and electron spectra. The internal conversion process is 70 to 90% E0, while total transition intensities are 3 to 8% E0. These E0 admixtures appear to be systematic in deformed nuclei and are useful for identifying K = 0 excited levels. (auth)

20652 DECAY OF ^{119m}Te AND THE LEVEL STRUCTURE OF ^{119}Sb. Singru, R. M.; Devare, S. H.; Devare, H. G. (Tata Inst. of Fundamental Research, Bombay). pp 934-8 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

The decay of ^{119m}Te was investigated using a germanium solid-state detector, a double-focusing spectrometer, and directional correlation techniques. The following levels in ^{119}Sb are proposed: 270 keV ($\frac{1}{2}^+$), 1048 keV ($\frac{1}{2}^+$, $\frac{3}{2}^+$), 1212 keV ($\frac{1}{2}^+$), 1365 keV ($\frac{3}{2}^-$), 2281 keV ($\frac{1}{2}^-$, $1\frac{1}{2}^-$), 2292 keV, 2349 keV ($\frac{3}{2}^-$, $1\frac{1}{2}^-$), and 2365 keV ($\frac{1}{2}^-$). (auth)

20653 TEST OF TIME-REVERSAL INVARIANCE USING THE MOESSBAUER TRANSMISSION OF THE 73-keV TRANSITION IN ^{193}Ir. Atac, M.; Chrisman, B.; Debrunner, P.; Frauenfelder, H. (Univ. of Illinois, Urbana). Phys. Rev. Lett., 20: 691-4(Mar. 25, 1968).

The real and imaginary parts of the E2-M1 mixing ratio of the 73-keV transition in ^{193}Ir were determined in an arrangement that requires no correction for Faraday rotation. The values $\mathrm{Re}\delta = +0.556 \pm 0.010$ and $\mathrm{Im}\delta = +0.6 \pm 2.1 \times 10^{-3}$ result in a phase angle between E2 and M1 of $\eta = +1.1 \pm 3.8 \times 10^{-3}$, thus showing no evidence for T nonconservation. (auth)

20654 INELASTIC ELECTRON SCATTERING FROM EVEN TIN ISOTOPES AND MICROSCOPIC THEORIES OF VIBRATIONAL STATES. Rimini, A. (Univ., Trieste, Italy); Sawicki, J.; Weber, T. Phys. Rev. Lett., 20: 676-9(Mar. 25, 1968).

Two- and four-quasiparticle microscopic theories are applied to fit the most recent data on the reactions ^{116}Sn(e,e')^{116}Sn(2_1^+,3_1^-). The effective nuclear force is the realistic nucleon-nucleon potential of Tabakin renormalized by the core-polarization corrections. The observed angular distributions and the absolute values of the form factors can be reproduced for quite reasonable values of the single-particle parameters. (auth)

20655 CALCULATION OF THE SPIN AND ENERGY DEPENDENCE OF THE FISSION WIDTH FOR ^{238}U AND ^{239}Pu. Kikuchi, Yasuyuki; An, Shigehiro (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 86-9(Feb. 1968).

The neutron capture-to-fission ratios of ^{239}Pu and ^{235}U were calculated using channel theory, and the energy and spin dependences of the fission width were studied. (D.C.W.)

20656 GAMMA RADIATION OF ^{219}Rn, ^{215}Po, AND ^{211}Pb. Dalmasso, Josette; Maria, Henriette (Faculte des Sciences, Nice). Compt. Rend., Ser. A and B, 265: 822-5(Oct. 9, 1967). (In French).

The γ radiation of ^{219}Rn in equilibrium with ^{215}Po was studied using a Ge n-i-p diode. Five new γ rays were observed. The decay scheme of ^{219}Rn is discussed. The energy of some γ rays of ^{211}Pb were found different from those indicated by Mead and Draper. (tr-auth)

20657 ENERGY LEVELS OF ^{117}In NUCLEI. Begzhanov, R. B.; Sabirov, Kh. S.; Salikhbaev, K. T.; Khodzhaev, M. M. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 8, 20-2(1967). (In Russian).

The half lives of 588-, 658-, 747-, and 1890-keV levels and γ-γ-angular correlations of the 1306-274 and 90-345 keV cascades in ^{117}In were measured (R.V.J.)

20658 EXCITED LEVELS OF ^{214}Po (RaC'). Ardisson, Gerard (Faculte des Sciences, Nice). Compt. Rend., Ser. A and B, 265: 1141-4(Nov. 13, 1967). (In French).

An energy level scheme for ^{214}Po is proposed on the basis of data from the γ spectra of ^{214}Bi. This scheme suggests a new interpretation of several long-path α particles of ^{214}Po. (tr-auth)

20659 DEPENDENCE OF THE RANGES OF SOME PLUTONIUM FISSION PRODUCTS ON THE EXCITATION ENERGY OF THE FISSIONING NUCLEUS. Rohde, G.; Muenzel, H. (Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta, 8: 96-102(Nov. 1967). (In German).

The ranges of some fission products (^{91}Sr, ^{92}Sr, ^{113}Ag, ^{113}Ag, ^{118}Cd, ^{139}Ba) from the fission of ^{239}Pu with thermal neutrons and 20 and 50 MeV deuterons were determined with the "thick target-thick catcher"-method. The total kinetic energies were calculated from the ranges and the results are discussed. The total kinetic energy for a mass ratio of approximately 0.8 and 1.3 (asymmetric fission) is independent of the excitation energy of the fissioning nucleus. The total kinetic energy in the range of symmetric fission is increased by 8 MeV between 5 and 20 excitation energy of the fissioning nucleus. Above 20 MeV it re-

mains almost constant. This result is in good agreement with the hypothesis of two independent fission modes (symmetric and asymmetric fission). The assumption, that the distribution of the excitation energy of the fissioning nucleus on the primary fission fragments is according to their mass, seems not to be consistent. This could be estimated from the number of evaporated neutrons in the range of symmetric fission. (auth)

20660 THE INTERNAL CONVERSION COEFFICIENT K OF THE 84.3-keV RADIATION EMITTED DURING THE DECAY $^{170}Tm \xrightarrow{\beta^-} {}^{170}Yb$. Ferreira, Jose G.; Salgueiro, Lidia Ferreira; Cardoso, Maria H.; Gil, Fernando B. (Faculte des Sciences, Lisbon). Compt. Rend., Ser. A and B, 265: 1135-7(Nov. 13, 1967). (In French).

The internal conversion coefficient in the K level of Yb of the γ ray of 84.3 keV was determined by scintillation spectrometry. Some corrections concerning the source composition and the x photons due to the electron capture of ^{170}Tm were made. The value $\alpha_K = 1.50 \pm 0.09$ was found. (tr-auth)

20661 EXISTENCE OF DEFORMED LEVELS IN ^{133}La. Abou-Leila, Hussein; Gerschel, Claudie; Perrin, Nils (Institut de Physique Nucleaire, Orsay, France). Compt. Rend., Ser. A and B, 265: 1131-4(Nov. 13, 1967). (In French).

By the use of time–amplitude circuits the mean life of two levels of ^{133}La was determined. The measurements confirmed the existence of deformed levels in this nucleus where the ground state has spherical symmetry. (tr-auth)

20662 THE LOW-ENERGY γ RADIATION OF ^{226}Ra AND ITS DERIVATIVES AND THE MULTIPOLAR CHARACTER OF SOME γ TRANSITIONS OF ^{214}Po. Maria, Henriette (Faculte des Sciences, Nice). Compt. Rend., Ser. A and B, 265: 1138-40(Nov. 13, 1967). (In French).

The low-energy γ radiation of ^{226}Ra and its derivatives were studied with a Ge(Li) detector. The attribution to ^{214}Po of several γ transitions was confirmed. The low-energy data, together with that obtained previously using a pair spectrometer, permitted the determination of the internal conversion coefficients α_K and the multipolar character of several transitions of ^{214}Po. (tr-auth)

20663 VIBRATIONAL AND ROTATIONAL SPECTRA IN THE REGION OF THE BARIUM ISOTOPES. Manfredi, V. R.; Ricci, R. A. (Univ., Florence). Nuovo Cim. (10), 53B: 210-15(Jan. 11, 1968).

Experimental and theoretical work on the rotational and vibrational spectra of the even neutron-deficient isotopes of Ba is reviewed. (S.F.L.)

20664 THE PROPERTIES OF ROTATIONAL BANDS AT LEVELS WITH $K = \frac{1}{2}$: THE ENERGY ASPECT. Dzhelepov, B. S.; Dranitsyna, G. F. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 171-8(Jan. 1967). (In Russian).

The energies of the rotational bands for levels with $K = \frac{1}{2}$ are calculated for the 42 nuclei for which this state is known. Using literature data published by November 1, 1965, the weighted functions for energy transitions were derived to calculate the energy levels by the least-square method. The Bohr–Mottelson formula was selected. The energy values are tabulated in groups with the same asymptotic quantum number. (JPRS)

Nuclear Theory

Refer also to abstracts 20130, 20215, 20280, 20286, 20287, 20293, 20317, 20434, 20444, 20464, 20469, 20479, 20481, 20483, 20487, 20496, 20497, 20499, 20522, 20531, 20533, 20540, 20541, 20551, 20574, 20578, 20599, 20601, 20607, 20615, 20625, 20626, 20642, 20644, 20649, 20654, and 20655.

20665 (EUR-3882) SQUID-360: A MULTIGROUP DIFFUSION PROGRAM WITH CRITICALITY SEARCHES FOR THE IBM-360. Daneri, A.; Gabutti, B.; Salina, E. (GIAT, Turin (Italy). Sezione Energia Nucleare). Dec. 7, 1967. 127p. Dep.

The two-dimensional diffusion program SQUID-360, which is written in FORTRAN IV for the IBM-360/65, is described. The one-line Chebyshev semi-iterative method is used to solve the finite difference equations. The program features the solution of nonhomogeneous problems, solution of adjoint problems, three types of criticality searches, and restart of interrupted problems. (D.C.W.)

20666 (FEI-79) OTNOSITEL'NYE VEROYATNOSTI VOZBUZHDENIYA IZOMERNYKH SOSTOYANII PRI RADIATSIONNOM ZAKHVATE TEPLOVYKH NEITRONOV. (Relative Probabilities of the Excitation of Isomeric States During Radiative Capture of Thermal Neutrons). Malyshev, A. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1967. 11p. (In Russian). Dep.

The relative probabilities of the formation of isomeric states during the radiation capture of thermal neutrons are calculated on the basis of the statistical theory. The calculations are carried out by a method that takes into account the distribution of the γ-ray sources for each cascade, with the object of verifying the dependence of the density of nuclear levels on the total angular momentum. On using as an example eight odd-odd nuclei for which the isomeric relations differ by a factor of ~30, it is shown that on specifying a single parameter of the theory—the density of single-particle states in the neighborhood of Fermi energy—agreement with experiment is achieved within the limits of 50%. (tr-auth)

20667 (INR-830/I/PL) ZAGADNIENIA STRUKTURY JADER ATOMOWYCH I REAKCJI JADROWYCH WYWOLANYCH PRZEZ NEUTRONY. (Some Problems Connected with Nuclear Structure and Neutron Induced Reactions). Turkiewicz, J. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 57p. (In Polish). Dep.

Several aspects of the energy dependence of the cross sections for fast neutron-induced reactions as well as some problems of the cluster structure of nuclear surface are presented. (auth)

20668 (LA-DC-9179) REAL PART OF THE FORWARD SCATTERING AMPLITUDE. Stewart, Leona (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 18p. (CONF-680307-25). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

Wick's derivation of the lowest limit for the zero-degree cross section in the elastic scattering of neutrons is now frequently employed as a good approximation to the cross section itself. Derived from the optical theorem, Wick's Limit is simply the imaginary part of the amplitude squared. Through the direct relationship to the total cross section it becomes an important tool in evaluation and interpretation. Using the "strong absorption" assumption in all partial waves, the real part of the amplitude reduces to zero, but this assumption also predicts polarizations which are identically zero. Since large neutron polarizations have been observed for many elements in the MeV region, the conditions under which the real part of the forward scattering amplitude approaches zero are studied in more detail. Complex phase-shift expansions show important relationships between the total, elastic, and reaction cross sections and the elastic angular distributions. Certain conditions under which Wick's Limit becomes a poor approximation to the zero-degree cross section are examined. The real and imaginary parts of the amplitude and the total and partial cross sections have been calculated for the $d_{\frac{3}{2}}$ state of A = 56 using the optical model with real and complex potentials. (auth)

20669 (NP-17228) PROCEEDINGS OF THE LIPERI SUMMER SCHOOL IN THEORETICAL PHYSICS, 1966. B. NUCLEAR PHYSICS. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). 1967. 165p. Dep.

Separate abstracts were prepared for the six sections of the proceedings. (D.C.W.)

For abstracts of individual sections see: 20670–20675.

20670 (NP-17228, pp 3-24) COLLECTIVE EFFECTS IN SPHERICAL NUCLEI. Sorensen, Raymond A. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics).

A qualitative description of various collective motions is presented in classical terms. The wide applicability of the random phase approximation to the treatment of collective phenomena is stressed. (D.C.W.)

20671 (NP-17228, pp 25-55) PARITY DEFORMATION AND PAIRING WITHIN A SOLVABLE MODEL. Schuette, Dieter (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics).

An exactly solvable model that takes into account parity deformation is outlined. The Hartree-Fock approximation, projection of Hartree-Fock states on parity, perturbation theory, and the random phase approximation are applied to the model; and the results are compared with the exact solutions. A generalization of the model is made by taking into account pairing matrix elements. The limits of the effect of parity deformation on heavy nuclei are studied by comparing magnetic moments, single-particle level shifts, and the excitation energy of vibrational states. (D.C.W.)

20672 (NP-17228, pp 56-69) PAIRING-MODEL WITH SPECIAL ATTENTION TO DEFORMED MODEL. Wahlborn, S. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics).

A fairly general model for pairing in a system of nucleons is outlined, disregarding the neutron–proton interaction. The application to deformed nuclei is stressed, and it is shown that the BCS approximation can be used in many instances. (D.C.W.)

20673 (NP–17228, pp 70–103) ALPHA DECAY THEORY. Sandulescu, A. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics).

The alpha-nucleus potential is studied, considering a superposition of a Coulomb and a nuclear potential; and a model of two spinless particles in a harmonic oscillator potential is described. Theoretical results for both spherical and deformed nuclei are compared with experimental data. It is concluded that the shell model with pairing and quadrupole interactions gives a satisfactory description of alpha decay. Specifically, the superfluid model satisfactorily describes the general trends of the experimental data. (D.C.W.)

20674 (NP–17228, pp 104–29) RECENT DEVELOPMENT IN DIRECT REACTION THEORY. Kuemmel, H. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics).

Some problems in the theory of direct reactions are discussed; and their solutions, if known, are indicated. It is stressed that the validity of the distorted-wave Born approximation is still a controversial matter, and improvement of the distorted-wave Born approximation by taking into account the exclusion principle and the three-body approximation is discussed. (D.C.W.)

20675 (NP–17228, pp 130–60) OPTICAL POTENTIALS FOR COMPOSITE PARTICLES. Bencze, Gy. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics).

The optical potentials for light composite particles such as deuterons, tritons, ^{3}He particles, and alpha particles are discussed from the viewpoint that the potentials for composite particles can be related to the potentials for the constituent nucleons and the composite potential should be as deep as the sum of the potentials acting on the constituent nucleons. Some experimental support for the predictions of this theoretical approach is outlined. (D.C.W.)

20676 (STI/PUB-21/27) PHOTONUCLEAR REACTIONS. VOL. II (1963–1966). Bibliographical Series No. 27. (International Atomic Energy Agency, Vienna (Austria)). Nov. 1967. 310p. IAEA: $6.50; Austrian Schillings 168,–; £ 2.6.0; F Fr 31,90; DM 26,–.

References (1566) to literature dealing with the interactions of electromagnetic waves with nuclei and elementary particles are presented. Abstracts are included with most of the references. Author and subject indexes are also provided. (D.C.W.)

20677 (UCRL–50359) THE CALCULATION OF LOW-ENERGY (n,p) REACTIONS. Lutz, H. F.; Anderson, J. D. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 6, 1967. Contract W-7405-eng-48. 13p. Dep. CFSTI.

The statistical theory of nuclear reactions is used to calculate low-energy (n,p) reactions on unstable isotopes near mass numbers 45 and 90. Neutron energies up to 1 MeV are considered. Isomeric states of unstable nuclei are also taken as target nuclei; the results indicate that the (n,p) cross sections on these levels can be quite large. The transmission coefficients are calculated from an optical model, and Moldauer's code NEARREX is used to make the statistical model calculation. (auth)

20678 COULOMB DISPLACEMENT ENERGIES OF ISOBARIC ANALOGUE STATES. Lindner, Albrecht (Univ., Hamburg). Z. Phys., 211: 195-212(Mar. 12, 1968). (In German).

The splitting of isobaric multiplets caused by the differences in kinetic energies and magnetic moments is estimated. The differences in Coulomb energies are calculated, assuming the radial charge distribution to be given by a Fermi function as deduced from electron scattering. As a result, the diffuseness is more important than antisymmetrization and much more important than the deformation. The decrease of the charge radius with increasing neutron excess found from muonic x rays, has to be taken into account for heavy nuclei. Approximating this effect by a two-parameter formula and using the radius parameter and diffuseness derived from electron scattering and muon atoms, good overall-agreement with experimental data is achieved. (auth)

20679 INTERNUCLEAR INTERACTION IN IRREDUCIBLE FORM. VI. CALCULATION OF THE BINDING ENERGY FOR LIGHT NUCLEI. Petrauskas, A. K.; Vanagas, V. V. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 7: 101-15 (1967). (In Russian).

The operators for kinetic and Coulomb energy in irreducible form are presented. An expression of matrix elements for such operators in terms of submatrices of the orbital interaction in the most important cases is given. The binding energy of nucleus in states described by means of the wave functions with orbital symmetry [44 ... 4k] (k^-0,1,3) is calculated. (auth)

20680 CENTRAL INTERNUCLEAR INTERACTIONS IN IRREDUCIBLE FORM. V. ORBITAL INTERACTIONS SUBMATRICES IN THE SHELL MODEL. Petrauskas, A. K.; Vanagas, V. V. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 7: 85-99(1967). (In Russian).

The method of calculation of submatrices for orbital irreducible operators in the shell-model approximation for the real internuclear interaction for oscillator wave functions is presented. The contribution of nonsymmetrical interactions to the matrix of the central interactions in the case of a configuration $(os)^4\,(op)^{n-4}$ is discussed. (auth)

20681 SYSTEMATIC COMPARISON BETWEEN BORN APPROXIMATION AND DISTORTED-WAVE BORN APPROXIMATION FOR INELASTIC ELECTRON SCATTERING. Toepffer, Christian (Univ. of Virginia, Charlottesville); Drechsel, Dieter. Z. Phys., 210: 423-33(1968).

The correction factors for Coulomb effects in inelastic electron scattering are given for electric quadrupole transitions. The cross sections in Born approximation and distorted-wave Born approximation are calculated in the liquid drop model for electron energies between 20 and 80 MeV and nuclei up to Z = 26. (auth)

20682 FORM FACTOR OF THE STRIPPING REACTION IN THE HARTREE–FOCK APPROXIMATION. Sugawara, Kazuko (Tokyo Univ. of Education). Nucl. Phys., A110: 305-16(1968).

The form factor which appears in the DWBA is a more complicated one than that suggested by the simple wave function in a single-particle well. The influence of the important two-body interaction in residual and target nuclei, which is neglected in the conventional theories, is taken into account. The quasi-spin formalism is used, and numerical calculations are performed for Ca and O isotopes. The results imply that there are discrepancies of 20 to 30% in the cross sections between these calculations and the usual Woods-Saxon calculations. (auth)

20683 COMPARISON BETWEEN A BOSON-EXPANSION METHOD AND THE EXACT SOLUTION IN A TWO-LEVEL MODEL. Broglia, R. A.; Soerensen, B. (Univ. of Copenhagen). Nucl. Phys., A110: 241-56(1968).

A detailed comparison is made, between the boson method developed by Sorensen following the ideas of Belisev and Zelevinsky and an exact solution of a two-level system of like particles interacting via a pairing force. (auth)

20684 COLLECTIVE GYROMAGNETIC RATIOS OF DEFORMED NUCLEI. Prior, O. (Lund Inst. of Tech., Sweden); Boehm, F.; Nilsson, S. G. Nucl. Phys., A110: 257-72(1968).

The effective gyromagnetic ratios of the ground-state rotational band in deformed nuclei are calculated on the basis of the cranking model formula. The latter is evaluated in terms of deformed shell-model wave functions with inclusion of pair correlations. Comparison with experimental data both as to doubly even and odd-mass nuclei shows in general very good agreement within a range determined by the present experimental inaccuracy and the uncertainty in the specification of the nuclear-model parameters. (auth)

20685 ACCURACY OF THE LOCAL ENERGY APPROXIMATION TO NON-LOCALITY EFFECTS ON BOUND-STATE WAVE FUNCTIONS. Ulrici, W. (Univ. Frankfurt-a. Main); Hering, W. R. Nucl. Phys., A110: 281-88(1968).

The local energy and the Perey-Buck approximations used to simulate nonlocal shell-model calculations were examined. The accuracy of the local energy approximation, with the wave functions corrected by the Perey factor, was found to be surprisingly good. (auth)

20686 LEVEL DENSITY PARAMETER IN THE MASS REGION 24 TO 48. Tiwari, P. N.; Kondaiah, E. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., A110: 317-20 (1968).

The cross sections for several (n,p), (n,α), and (n,2n) reactions leading to residual nuclei in the mass range 24 to 48 at 14.2 MeV neutron energy are calculated by the statistical model using the level density parameter $a = \frac{1}{8}A$. The theoretical values are compared with earlier experimental values. From this comparison, it is concluded that the value of the level density parameter ($a = \frac{1}{8}A$) used in these calculations is approximately correct in the mass region 24 to 48. (auth)

20687 SHORT-RANGE CORRELATIONS AND THE TRINUCLEON. Lim, T. K. (Univ. of Adelaide). Nucl. Phys., A110: 417-28(1968).

The effect of short-range correlations in the tri-nucleon is considered by employing suitable forms for the spatial part of the totally antisymmetric S-state wave function. The parameters of the trial wave functions, which are of product form with two-particle correlation functions introduced to simulate the presence of a soft repulsive core, are obtained by fitting the r.m.s. radius and the body form factor of the three-nucleon system. Using a modification of Srivastava's central velocity-dependent potential, good agreement with the binding energy of ^{3}H and the photodis-integration cross section of ^{3}He are obtained, with the exponential wave forms. (auth)

20688 STUDIES OF ODD-MASS Co ISOTOPES IN THE UNIFIED MODEL. Satpathy, L.; Gujrathi, S. C. (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys., A110: 400-16(1968).

An explanation of the properties of the low-lying levels of the odd mass Co isotopes and the interpretation of the (t,α) reactions on the even-mass Ni isotopes are presented on the basis of the intermediate coupling approach of the unified model. It is assumed that a Co isotope has a structure formed by coupling of a proton hole to the quadrupole vibrations of the corresponding even-mass nucleus. The core states up to three phonons are considered in the calculation. The phonon energy $\hbar\omega$ is taken as the energy of the first excited state of the neighboring Ni isotope. The proton-hole states are assumed to be $(1f_{\frac{7}{2}})^{-1}$, $(1d_{\frac{3}{2}})^{-1}$, and $(2s_{\frac{1}{2}})^{-1}$. The coupling strength ξ is the only variable parameter which enters into the calculation of the negative-parity states. The energies of states $(1d_{\frac{3}{2}})^{-1}$ and $(2s_{\frac{1}{2}})^{-1}$ with respect to $(1f_{\frac{7}{2}})^{-1}$ are treated as the variable parameters in the calculation of the positive-parity levels. The isotopes considered are ^{57}Co, ^{59}Co, ^{61}Co, and ^{63}Co. The calculated energy levels, spins, parities, nuclear moments, and transition probabilities are in good agreement with the experimental results. The calculated spectroscopic factors for the $^7/_2^-$, $^1/_2^+$, and $^3/_2^+$ states agree reasonably well with the experimental results of the (t,α) reactions on the even-mass Ni isotopes. (auth)

20689 PROJECTED HARTREE-FOCK SPECTRA IN 1f-2p SHELL NUCLEI. Khadkikar, S. B.; Gunye, M. R. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., A110: 472-80(1968).

The projected Hartree-Fock technique is used to calculate energy spacings and the electromagnetic properties of even-isotopes of Ca, Ti, Ni, Zn and some odd-mass isotopes of Cu. The energy spacings are found to be smaller than the experimentally observed ones, while the (B(E$\downarrow$2$\uparrow$) quadrupole transition reduced matrix elements compare fairly well with the experimental values. (auth)

20690 COMPUTER ANALYSIS OF SMALL-ANGLE SCATTERING AND APPLICATION TO PROTON-NUCLEI SCATTERING AT 3 GeV/c. Bernheim, A. (Faculte des Sciences, Paris); Capette, H.; Fayolle, J. C.; Le Barbu, J. C.; Lefevre, J.; Van Hollebeke, M.; Morand, M.; Faucher, G. J. Phys. (Paris), 29: 1-3(Jan. 1968). (In French).

Computer test programs, based on statistical methods of small angle scattering detection, provide directly the measurement of the events, thereby reducing the scanner's bias. Application is made to the 3-GeV/c p-nucleus interaction in nuclear emulsion. (auth)

20691 NUCLEAR DEFORMATIONS IN THE PAIRING-PLUS-QUADRUPOLE MODEL. II. DISCUSSION OF VALIDITY OF THE MODEL. Baranger, Michel (Carnegie-Mellon Univ., Pittsburgh); Kumar, Krishna. Nucl. Phys., A110: 490-528(1968).

An attempt is made to choose the parameters of the pairing-plus-quadrupole model as realistically as possible. A correction is introduced to take into account the different numbers of neutrons and protons. An expression is given for the deformation energy of a nucleus with an arbitrary two-body interaction. Then the pairing-plus-quadrupole matrix elements are compared with those of more realistic interactions, and it is decided to keep only matrix elements between states of two adjacent oscillator shells. An argument is given to determine a priori the strength of the quadrupole force, and various corrections to this are discussed. No similar argument is found for the pairing force. Residual effects of the remaining oscillator shells are included in an approximate fashion. Comparison with previous work along these lines is presented. (auth)

20692 NUCLEAR DEFORMATIONS IN THE PAIRING-PLUS-QUADRUPOLE MODEL. III. STATIC NUCLEAR SHAPES IN THE RARE-EARTH REGION. Kumar, Krishna (Massachusetts Inst. of Tech., Cambridge. Michigan State Univ., East Lansing); Baranger, Michel. Contract AT(30-1)-2098. Nucl. Phys., A110: 529-54(1968). (MIT-2098-363).

The potential energy of deformation $V(\beta,\gamma)$, is calculated with the pairing-plus-quadrupole model for nuclei with N = 82 to 126, Z = 50 to 82. There is a sudden onset of deformation in the N = 86-90 region, and the static nuclear shape, the lowest minimum of the potential function, changes from spherical to prolate. The disappearance of deformation in the Z = 74 to 80 region is more gradual, and the static shape changes from prolate to asymmetric to oblate to spherical. The energy of zero-point motion is calculated, and it is concluded that all the stable deformed shapes of the region are prolate. Proton and neutron energy gaps, intrinsic quadrupole moments, moments of inertia, and gyromagnetic ratios of the doubly even nuclei of the rare-earth region are calculated and are compared with the experimental data. (auth)

20693 NUCLEAR PHYSICS. Spicer, B. M. (Univ. of Melbourne). Aust. J. Sci., 30: 247-54(Jan. 1968).

A brief review of the present understanding of nuclear structure, reaction mechanisms, and forces is presented. (D.C.W.)

20694 CONTRIBUTION TO THE DETERMINATION OF TOTAL COEFFICIENTS OF BETA BACKSCATTERING. Krivan, Viliam (Chemical Engineering Faculty, Bratislava). Fyz. Cas., 17: 106-14(1967).

The problems of understated values of backscattering coefficients obtained because the correction for absorption based on extrapolation of absorption curves using G-M counter detection is not sufficient are discussed. Possibilities of obtaining the correct backscattering coefficient values are investigated and discussed. (JPRS)

20695 MATRIX ELEMENTS STATISTICS IN THE SHELL MODEL. Gervois, A. (Centre d'Etudes Nucleaires de Gif-sur-Yvette, Saclay, France). Phys. Lett., 26B: 413-17(Mar. 4, 1968).

In the shell model a good approximation of the nuclear properties is obtained by limiting the number of configurations, the contribution of the others being treated in a statistical way. It is shown by simple example that the distribution law of the one matrix element (either in the neglected configurations or between important and neglected ones) is compatible with a Gaussian. (auth)

20696 EFFECTIVE TWO-NUCLEON INTERACTION FROM AN ANALYSIS OF THE REACTION ^{16}O(t,p)^{18}O. Kolltveit, K.; Muthukrishnan, R.; Trilling, R. (Michigan State Univ., East Lansing). Phys. Lett., 26B: 423-5(Mar. 4, 1968).

Effective two-body matrix elements in the s-d shell are extracted from the ^{18}O wave function previously obtained. The matrix elements are tabulated and are compared with results from shell-model calculations. (auth)

20697 SPECTRA OF ODD-ODD NUCLEI. Osadchiev, V. M.; Troitski, M. A. (Kurchatov Atomic Energy Inst., Moscow). Phys. Lett., 26B: 421-2(Mar. 4, 1968).

For spectra of odd-odd nuclei with an odd particle in a state of low angular momentum, an equation for the amplitude of interaction in a channel where the coordinate dependence of the residual interaction is not essential is written. (auth)

20698 DISPERSION EFFECTS IN ELECTRON SCATTERING. Toepffer, C. (Univ. of Virginia, Charlottesville. Univ., Frankfurt am Main). Phys. Lett., 26B: 426-8(Mar. 4, 1968).

Dispersion effects in the scattering of high-energy electrons on nuclei are calculated within the eigen-channel theory. Virtual excitations between the groundstate and three excited nuclear states lead to 20% corrections of the elastic and up to 100% corrections of the inelastic DWBA cross sections. (auth)

20699 PROTON HOLE STATES OF ODD PARITY IN 2s1d-SHELL NUCLEI. Wagner, G. J. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett., 26B: 429-31(Mar. 4, 1968).

Separation energies of $1p_{\frac{3}{2}}$ and $1p_{\frac{1}{2}}$ protons from 2s-1d shell nuclei are calculated by use of a parametrized particle-hole interaction. The calculation accounts for the surprisingly low binding energy of p-shell protons observed in (d,^{3}He) reactions. (auth)

20700 NUCLEAR DYNAMICS AND THE X-RAY SPECTRUM OF MUONIC ATOMS. Pieper, Wilhelm; Greiner, Walter (Univ., Frankfurt am Main). Nucl. Phys., A109: 539-60(1968).

The effect of nuclear rotations, surface vibrations, and giant multipole oscillations on the x-ray spectrum of a muonic atom is discussed. The polarization of nuclear states due to the muon is calculated for various nuclei. A detailed comparison of 3d-2p and 2p-1s transitions with theoretical predictions is given. Compared to nondynamical fits of muonic x-ray spectra one has 1 parameter less, namely the surface thickness. It is due to the zero point rotations and vibrations that the intrinsic homogeneous charge distributions gets smeared out. The excitation of β- and γ-vibrations by the muon is by a factor 10^{-3} less probable than the excitation of the first rotational states. (auth)

20701 S′ STATE IN THE TRINUCLEON. Lim, T. K. (Univ. of Adelaide). Nucl. Phys., A109: 641-8(1968).

The relative probability ($P_{S'}$) of the mixed-symmetry S-state (the S′ state) in the ground state of the trinucleon, is determined by fitting the charge form factors and the muon capture rate of the three-particle system. The spatial wave functions used in this work are of exponential form with two-body correlations in the predominant totally symmetric S-state and have been proved sufficiently flexible in our recent binding energy calculations. Results indicate that $P_{S'}$ cannot exceed 1.5%. (auth)

20702 ISOSPIN AND NUCLEAR LEVEL DENSITY. Kanestroem, I. (Univ. of Oslo, Blindern, Norway). Nucl. Phys., A109: 625-32(1968).

Level densities of nuclei of A = 24 and 28 are calculated as a function of the isospin and the total angular momentum. A statistical treatment is used, and the level densities are calculated for a system of free particles and a system with the symmetry energy term taken into account. The symmetry term is found to be of importance in the calculation of the level density, but the angular momentum distribution among the states is in good agreement with the previous calculations. (auth)

20703 MANY BODY THEORY. Brown, G. E. (Princeton Univ., N. J.). pp 41-94 of Proceedings of the Liperi Summer School in Theoretical Physics, 1967. Helsinki, University of Helsinki, 1967.

Perturbation theory is used to calculate properties of the ground state or of states which do not differ much from the ground state. The state ϕ is treated as the normal state, and only particles added to it or particles missing from it (holes) are discussed. In this way it is treated as the unperturbed or bare vacuum in field theory. (J.F.P.)

20704 PROTON POLARIZATION IN COULOMB STRIPPING. Drukarev, G. F. (Leningrad State Univ.); Ippolitov, V. T. Nucl. Phys., A110: 218-24(1968).

The study concerns the spin-orbit Mott-Schwinger interaction in the Coulomb stripping of deuterons. This interaction is shown to cause an appreciable proton polarization in the exit channel. The polarization is calculated as a function of the reaction angle and energy for the capture of an S-state neutron. (auth)

20705 K = 1,2,3 OCTUPOLE VIBRATIONS. Lipas, P. O.; Kurki-Suonio, K.; Peltola, E. (Univ. of Helsinki). Nucl. Phys., A110: 211-17(1968).

Applying the Bohr-Mottelson hydrodynamic model, a coupled Schrödinger equation yielding the K = 1, 2, 3 octupole vibrations in deformed even nuclei (the K = 0 state is obtained trivially) is developed and solved. For higher states, K does not appear to be a good quantum number. The simple rotation-vibration picture in the adiabatic approximation and neglect quadrupole-octupole coupling is assumed. The model does not fix the energies; it permits any order among the K = 1, 2, 3 states. (auth)

20706 POLARIZATION-ASYMMETRY DIFFERENCE IN THE SCATTERING OF MEDIUM-ENERGY NUCLEONS. Tindle, C. T. (Univ. of Auckland, N. Z.). Nucl. Phys., A110: 193-203 (1968).

The scattering of 150 to 180 MeV nucleons from light targets is formulated using the impulse and WKB approximations. Results are in agreement with similar results presented elsewhere. The difference between polarization and asymmetry is calculated, and results presented for ^{12}C and ^{40}Ca. The difference is strongly dependent on the optical parameters and is expected to be large for transitions to excited states in which the excited nucleon changes shell. (auth)

20707 ON SUPERCONDUCTIVITY EFFECTS IN NUCLEAR LEVEL DENSITY. Decowski, P.; Grochulski, W.; Marcinkowski, A.; Siwek, K.; Wilhelmi, Z. (Univ. of Warsaw. Inst. of Nuclear Research, Warsaw). Nucl. Phys., A110: 129-41(1968).

The formulae and results of calculations of the nuclear level density based on the theory of superconductivity are presented. The obtained formulae do not contain any open parameters. They account for the shell and odd-even effects. The results of calculations are compared with experimental level densities and nuclear temperatures for Co and In nuclei. The agreement is satisfactory and better than in the case when the shifted Fermi gas model formulas are applied. (auth)

20708 ON THE ENERGY DEPENDENCE OF THE EMPIRICAL OPTICAL POTENTIAL. Passatore, G. (Univ., Genoa). Nucl. Phys., A110: 91-110(1968).

The energy behavior of the real part of the empirical potential for nucleons is derived starting from the energy dependence and the non-locality of the generalized optical potential defined in the many-body nuclear problem. Its energy dependence is evaluated by means of a dispersion relation, and the effect of the non-locality is calculated in terms of a suitable form factor for the non-local kernel. A good over-all agreement with experimental data for neutrons and protons from 10 MeV to 1 GeV is obtained and an estimate of about 0.8 fm for the range of non-locality of the generalized optical potential is indicated. (auth)

20709 INTERNAL PAIR FORMATION AND MULTIPOLARITY OF NUCLEAR TRANSITIONS. Lombard, Roland J. (CNRS, Orsay, France); Perdrisat, Charles F.; Brunner, Jean H. Nucl. Phys., A110: 41-55(1968).

The use of internal pair formation data to the determination of nuclear transition multipolarities is discussed. The results of new "exact" calculations using Dirac electron wave functions for a point charge nucleus are presented in tables and graphical form for E0, E1, M1, and E2 transitions. The results of calculations with a modified Born approximation for M2 and E3 multipolarities are also presented. The experimental data are reviewed and compared with the numerical results of this work. (auth)

20710 BETA DECAY. PART II. Janouch, Frantisek; Vinduska, Milan (Ceskoslovenska Akademie Ved, Rez). Cesk. Cas. Fys., 18: 71-91(1968). (In Czech).

An interpretation of the present state of the theory of beta decay is presented. The lg ft values for allowed and forbidden transitions are discussed and the methods of calculating nuclear matrix elements are judged. The influence of the Coulombic field of a nucleus and the finite dimensions of a nucleus on beta decay are considered. In the last section some more recent parts of the theory of beta decay (CVC, induced coupling, radiative corrections) are explained and their influence on the probability, and polarization and correlation experiments in beta decay is discussed. (auth)

20711 SHELL-MODEL EIGENFUNCTIONS AND THE ASYMPTOTIC REQUIREMENTS. Morsy, M. W.; Abu-Leilah, M. M. (Atomic Energy Establishment, Cairo). Atomkernenergie, 13: 95-9(1968).

A method is proposed for the modification of the harmonic-oscillator eigenvalue problem that provides a complete set of eigenfunctions which have the proper asymptotic behavior. The method is extended to extract the eigenparameters of the truncated oscillator potential, which incorporates the observed nuclear single-particle features. Results for the case of ^{17}O nucleus have been obtained. (auth)

20712 FINITE RANGE KNOCK-OUT REACTIONS. El-Nadi, M.; Rihan, T. H. (Atomic Energy Establishment, Cairo). Atomkernenergie, 13: 101-4(1968).

The finite-range knock-out processes for the general case of captures in arbitrary L are considered. For the description of bound states, the cluster model was adopted together with wave functions of the oscillator form. Choosing the central potential to be of the Gaussian form, it was found that the angular distribution is very sensitive both to the range of the interaction and to the parameters of the wave functions. As the range increases, the differential cross section tends to decrease in the forward and increase in the backward directions. When the oscillator parameters are varied, it is observed that the magnitude of the cross section decreases as they increase. (auth)

20713 ENERGY DEPENDENCE OF THE DEUTERON OPTICAL-MODEL POTENTIAL. Rawitscher, George H. (Univ. of Connecticut, Storrs). Phys. Rev. Lett., 20: 673-6 (Mar. 25, 1968).

It is shown that for the case of ^{40}Ca a large part of the energy dependence of the deuteron optical-model parameters is due to the presence of the stripping channels. (D.C.W.)

20714 SYSTEMATICS OF NEUTRON SEPARATION ENERGIES FOR EVEN-EVEN NUCLEI. Banerjee, D. (Palit Lab. of Physics, Calcutta). Phys. Rev. Lett., 20: 599-600(Mar. 18, 1968).

The variation of the neutron separation energies of even-even nuclei with the total angular momentum (J) of the preceding odd neutron, with the neutron numbers (N), and with the atomic number (Z) was investigated. It was observed that the separation energies do not vary linearly with N in a strict sense and that the separation energies of even-even nuclei with the same J and for a fixed isotope lie on a straight line. Shell effects were also observed. (D.C.W.)

20715 POLOLOGY AND (d,p) REACTIONS. Bertram, W. K.; Tassie, L. J. (Australian National Univ., Canberra). Phys. Rev., 166: 1029-35(Feb. 20, 1968).

Cross sections for (d,p) reactions calculated in the physical region are extrapolated to the Butler pole in order to investigate the possibility of extracting reduced widths. The cross sections are calculated by distorted-wave Born approximation (DWBA), using a method of evaluation yielding cross sections with the correct analytic behavior near the pole. The cross sections in the

unphysical region between the pole and the start of the physical region are calculated and compared with the extrapolation of cross sections from the physical region. Detailed calculations are made for two reactions in which the neutron is captured into an s state: $^{28}Si(d,p)^{29}Si$ to the ground state, and $^{12}C(d,p)^{13}C$ (3.09 MeV). It is found that an effect of the Coulomb interaction prevents accurate extrapolation to the pole for heavy nuclei or low energies. The method of evaluating the DWBA cross section has an advantage over the usual method in that fewer partial waves need be summed. (auth)

20716 USE OF THE PROJECTION-OPERATOR METHOD IN NUCLEAR REACTION THEORY. Tobocman, W. (Case Western Reserve Univ., Cleveland). Phys. Rev., 166: 1036-44 (Feb. 20, 1968).

Feshbach has shown how the introduction of the projection operator onto the bound states of a system of nucleons can facilitate the calculation of the transition amplitude for a nuclear scattering reaction. Feshbach's method is based on the relationship of the transition amplitude to the T matrix. In this paper we show how the projection-operator method can be applied to the generalized R-matrix expression for the transition amplitude. In order to test the validity of the approximations customarily employed in applications of the projection-operator formalism, we have applied the method to a simple soluble model. We find that the method works quite well provided that all second-order terms are retained. The generalized R-matrix method is found to work better than the T-matrix method, but the R-matrix method depends sensitively on the choice of the value of the boundary radius. (auth)

20717 DEVIATIONS FROM THE I(I + 1) LAW IN DEFORMED NUCLEI. Bes, D. R. (Carnegie-Mellon Univ., Pittsburgh); Landowne, S.; Mariscotti, M. A. J. Phys. Rev., 166: 1045-50 (Feb. 20, 1968).

The perturbation of the single-particle motion by rotation, in deformed nuclei, produces a change in the potential-energy surface. In this work, the values of the collective nuclear parameters are obtained as a function of the angular momentum I by minimizing the expectation value of the Hamiltonian for each value of I. In this way, a natural extension of the previous methods used in computing these energy surfaces enables one to calculate the deviations from the I(I + 1) law corresponding to rigid rotors. Comparisons with experimental data and previous theoretical calculations are included. (auth)

20718 MODEL ^{3}He PROBLEM WITH SEPARABLE INTERACTIONS. Adya, S. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 166: 991-6(Feb. 20, 1968).

The bound-state three-body system, with two of the particles charged, is considered using two approximate forms of the Coulomb Green's function $G^C(W)$. The nuclear potential between each pair is assumed to be of the separable s-wave form. The binding energy of the model ^{3}He system is calculated numerically for each of the two approximations for the Coulomb Green's function, and these results are compared with a first-order perturbation calculation. (auth)

20719 TWO-NUCLEON VIRTUAL LEVELS IN DIRECT NUCLEAR REACTIONS. Vymazal, M. (Nuclear Research Inst., Rez, Czech.). Nucl. Phys., A109: 236-40(1968).

Correlations of virtual nucleon pairs are considered in direct nuclear reactions. Such correlations do not practically influence the reaction amplitude for two-nucleon transfer (pick-up) reactions. They do influence the reaction amplitude for reactions with the knock-out of two nucleons, but an account of them does not give a simple "di-nucleon" propagator in the amplitude. (auth)

20720 T-MATRIX PERTURBATION THEORY AND ITS APPLICATION TO THE FADDEEV EQUATIONS. Fuda, M. G. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 166: 1064-7(Feb. 20, 1968).

A T-matrix perturbation theory is developed and applied to the Faddeev equations. This theory allows one to calculate the shift in the three-body binding energy produced by any part of the two-body T matrix which is neglected in a three-body calculation. Since the perturbation series is given in terms of an operator closely related to the two-body T matrix, the theory can be applied even when extremely singular potentials are used to describe the two-body interaction. (auth)

20721 OPTICAL MODEL OF THE NUCLEON–NUCLEUS INTERACTION. Hodgson, P. E. (Nuclear Physics Lab., Oxford). Annu. Rev. Nucl. Sci., 17: 1-32(1967).

A review is given of some of the main topics of interest in the optical-model analysis of nucleon–nucleus interactions. Attention is concentrated on selected recent analyses of experimental data that have yielded potentials that can be relied upon to fit the data to good accuracy. Discussions on the spin- and isospin-dependence and the nonlocality of the optical potential are included. The model has been mainly successful in describing elastic scattering, but extensions to include nonelastic processes are also reviewed. (S.F.L.)

20722 INTERNATIONAL NUCLEAR PHYSICS CONFERENCE, GATLINBURG, TENNESSEE, SEPTEMBER 12–17, 1966. Becker, Richard L. (ed.). New York, Academic Press, 1967. 1154p. $22.50. (CONF-660906).

A total of 178 papers are included in full; 122 papers are included in abstract form only. Separate abstracts were prepared for 127 of the papers for which the full text is included, 79 other papers have previously appeared in NSA; these papers can be located by referring to abstract numbers 20: 4235, 24440, 30431, 34522, 44768, 46713; 21: 4345, 4346, 9946, 9998, 13807, 19322, 24322, 27519, 27541, 31816; 22: 1612, 1714, 1734, 3545, 3734, 5896, 9792 and to CONF-660906 in the report number index. (D.C.W.)

For abstracts of individual papers see: 19092, 20130, 20131, 20442–20448, 20467–20486, 20531–20536, 20538–20546, 20623–20652, and 20723–20773.

20723 DISTORTED-WAVE t-MATRIX APPROXIMATION FOR SINGLE-PARTICLE REACTIONS. Amos, K. A. (Univ. of Pittsburgh); Lim, K. L.; McCarthy, I. E.; Madsen, V. A. pp 21-3 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The distorted-wave t-matrix approximation for quasi-three-body reactions is a distorted-wave representation of the two-nucleon t matrix rather than of the potential as for the DWBA. It is correct in the absence of the distorting potential. Preliminary antisymmetrized calculations reproduce experimental results for (p,p') and (p,2p) to within at least a factor of 2. (auth)

20724 EXPERIMENTAL STUDIES OF TRANSFER REACTIONS. Lee, L. L. Jr. (State Univ. of New York, Stony Brook). pp 31-46 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The type of spectroscopic information that can be obtained using transfer reactions is discussed, together with the extraction of spectroscopic information from the experimental data. In the latter connection, DWBA analysis is considered in some detail. (D.C.W.)

20725 DEUTERON STRIPPING THEORY: THE SUDDEN APPROXIMATION. Butler, S. T.; Hewitt, R. C.; McKellar, B. H. J.; May, R. M.; Truelove, J. S. (Univ. of Sydney). pp 55-8 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The sudden-approximation approach to deuteron stripping is used to derive (d,p) differential cross sections and polarization results which are evaluated numerically. The results depend on nucleon optical-model potentials which are not treated as adjustable but are assumed to be known. Theory and experiment agree for a range of reactions including heavy, medium, and light target nuclei. (auth)

20726 NONLOCAL EFFECTS IN THE DISTORTED-WAVE THEORY OF STRIPPING REACTIONS. Dickens, J. K.; Perey, F. G.; Silva, R. J. (Oak Ridge National Lab., Tenn.). pp 99-103 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Some $^{90}Zr(d,p)$ experimental data were analyzed with the distorted-wave theory. The need for an arbitrary cutoff radius in the evaluation of the stripping integral is completely eliminated when the nonlocality of the potentials used to generate the wave functions is taken into account. (auth)

20727 DEUTERON OPTICAL POTENTIAL. Johnson, R. C. (Battersea Coll. of Tech., London). pp 140-3 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The explicit contributions to the deuteron-nucleus optical potential from the stretching and breakup of the deuteron at the nuclear surface are estimated in a three-body model of the deuteron-nucleus Hamiltonian. Results of preliminary calculations for $^{40}Ca(d,d)$ at $E_d = 14.3$ MeV suggest that these contributions have a large effect on elastic scattering wave functions, but they can be taken into account by a simple modification of the conventional analysis. (auth)

20728 COHERENCE EFFECTS IN (p,^{3}He) REACTIONS. Hoot, Charles G. (Univ. of Minnesota, Minneapolis). pp 144-

7 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Angular distributions for (p,^{3}He) reactions on ^{12}C, ^{14}N, ^{16}O, ^{19}F, ^{25}Mg, and ^{27}Al were analyzed using the diffraction model of Henley and Yu. Coherence of the cross section in the single-particle states of the transferred nucleons is seen, for example, in the ^{14}N(p,^{3}He)^{12}C ground-state reaction where the ratio A_2/A_0 calculated using Glendenning's method is 2.75 and 1.03, respectively, for $(p_{\frac{1}{2}})^2$ pickup and True's ^{14}N wave functions without $(f_{\frac{5}{2}})^2$, and 0.83 when $(f_{\frac{5}{2}})^2$ is included. The experimental value is 0.7. (auth)

20729 ISOBARIC ANALOG STATES. von Brentano, Peter (Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 200-11 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The investigation of isobaric analog states by proton inelastic scattering is discussed together with the analysis of resonance reactions and isospin mixing in isobaric analog resonances. (D.C.W.)

20730 SPECTROSCOPIC FACTORS OF (p,n) REACTIONS. Goodman, Charles D. (Weizmann Inst. of Science, Rehovoth, Israel). pp 234-6 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Spectroscopic factors are calculated for (p,n) reactions with respect to an operator which simply inserts a proton and removes a neutron from single-particle states in the target. The calculations show that the internal structure of the states causes a concentration of spectroscopic strength in the analog state and a distribution of spectroscopic strength over nonanalog states. (auth)

20731 ELECTRON SCATTERING AND NUCLEAR STRUCTURE. Walecka, J. D. (Stanford Univ., Calif.). pp 289-309 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

A brief review of electron scattering is given, including the general form of the cross section in the one-photon-exchange approximation, and the information on nuclear structure that can be obtained from the various regions of the scattered electron spectrum is discussed. The knowledge of ground-state charge distributions from elastic Coulomb scattering is reviewed, as well as the information which can be obtained by elastic scattering through the transverse magnetic multipoles. The situation with respect to inelastic scattering to collective nuclear levels is summarized, with some emphasis placed on excitation of the supermultiplet of giant resonances through the transverse multipoles. The extent to which processes such as electron scattering and muon capture, which provide weak probes of the nucleus, complement each other is emphasized. The information contained in the quasielastic peak is discussed briefly, as well as the possibility of measuring nucleon-nucleon correlations in the region of larger energy loss and in coincidence experiments. The corrections to the one-photon-exchange approximation, including Coulomb distortion of the incoming and outgoing electron wave functions and the virtual excitation of intermediate nuclear states, are discussed. Finally, a few comments on electron excitation of the nucleon are made. (auth)

20732 NUCLEAR STRUCTURE EFFECTS IN ELECTRIC DIPOLE TRANSITIONS. Pauli, Chr.; Alder, K. (Univ., Basel). pp 327-31 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The sometimes large deviations of experimental internal conversion coefficients from the theoretical values of electric dipole transitions can be understood by means of the dynamic nuclear structure from which a parameter can be extracted. Since this nuclear parameter is constant for all conversion processes, it can be determined by a single experiment and checked by others. The agreement between theory and experimental data is good. (auth)

20733 ELECTRON INELASTIC SCATTERING FORM FACTORS OF THE GIANT DIPOLE RESONANCE STATES. Czyz, W.; Lesniak, L.; Malecki, A. (Instytut Fizyki Jadrowej, Krakow). pp 370-3 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

A simple method of calculation of the inelastic scattering form factors of the 1^-, T = 1 states is presented. This method is based on the optical electric dipole sum rules. The results are compared with the existing experimental data, and the results of calculations which employ the particle-hole model of the giant dipole resonance. (auth)

20734 INVESTIGATION OF MAGNETIC PROPERTIES OF NUCLEONS BOUND IN NUCLEI FROM AN INELASTIC ELECTRON SCATTERING SUM RULE. Czyz, W.; Lesniak, L.; Malecki, A. (Instytut Fizyki Jadrowej, Krakow). pp 374-7 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

A sum rule for the cross sections of electrons inelastically scattered from nuclei is analyzed. This sum rule contains contributions only from the transverse electron–nucleus interactions and is particularly suitable for analyzing experiments at $\theta = 180°$. Strong dominance of the spin-current contribution gives a very attractive possibility of measuring magnetic moments of nucleons bound in nuclei. Estimates of the short-range nucleon–nucleon correlation corrections to the sum rule are given. (auth)

20735 MUONIC X-RAYS AND NUCLEAR STRUCTURE. Wu, C. S. (Columbia Univ., New York). pp 409-35 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Recent great advances in the study of muonic x rays have made it possible to use the muonic atoms as a sensitive tool to study not only the charge distribution of the nucleus but the distribution of magnetic dipole (M1) and electric quadrupole (E2) moments in the nucleus as well. Both the Bohr–Weisskopf effect due to the distribution of magnetic dipole moments inside a finite nucleus and the dynamic electric quadrupole interaction in some strongly deformed nuclei have been observed, analyzed, and interpreted. The relation to the nuclear structure is discussed. The extreme sensitivity of muonic x rays to the finite charge distribution has been used to great advantage to study the phenomena of isotope shifts. Its merits and demerits in comparison with other methods of isotope studies are also discussed. Finally, some unsolved problems are mentioned, and the limitations of interpreting the muonic x rays set by present experimental and theoretical uncertainties are briefly discussed. (auth)

20736 PION INTERACTIONS WITH NUCLEI. Ericson, T. E. O. (CERN, Geneva). pp 437-48 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The experimental and theoretical situation in the field is reviewed. The connection between the elementary πN interaction and the elastic π-nuclear interaction is discussed in view of recent experiments. Information on nuclear structure from π absorption and scattering reactions is presented. (auth)

20737 NUCLEAR CONCEPTS RELATED TO ELEMENTARY PARTICLE PHYSICS. Lipkin, Harry J. (Weizmann Inst. of Science, Rehovoth, Israel. Argonne National Lab., Ill.). pp 450-7 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Models of elementary particles are discussed by analogy with nuclear models. In particular an "independent quark model" for strongly interacting particles is described. Like the nuclear shell model in its early days, the basic assumptions of independent particle motion seem very unreasonable, but the use of these assumptions without justification leads to predictions which are in agreement with experiment. Problems of separating effects of structure and reaction mechanism in interpreting experimental results are discussed. Possible applications of new concepts developed for elementary particles to nuclear structure are also considered, in particular the use of current algebras to obtain new nontrivial relations between nuclear electromagnetic and beta-decay matrix elements. (auth)

20738 NONMESONIC HYPERNUCLEAR DECAYS AND NUCLEAR CORRELATIONS. Adams, J. B.; Walecka, J. D. (Stanford Univ., Calif.). pp 470-3 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

For a Λ particle in nuclear matter, the only open decay channel is $\Lambda + N \rightarrow N + N$. It is argued that the correlations introduced into the initial and final wave functions by a hard core may select the one-pion exchange as the dominant decay mechanism because of its range and sensitively affect the decay rate. Some theoretical estimates of this rate are given. (auth)

20739 NUCLEAR MODELS. Bohr, Aage (Inst. of Theoretical Physics, Copenhagen). pp 489-95 of International Nuclear

Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.
The present status in the description of nuclear properties in terms of rotational and vibrational degrees of freedom is reviewed. The discussion of rotational motion centers upon the general formulation of the theory, the experimental test of rotational relations for energies and matrix elements, and the behavior of the rotating systems for large angular momenta. The discussion of vibrational motion deals with the symmetry classification of vibrational modes, anharmonicity effects, and the application of the microscopic description of collective motion. (auth)

20740 QUADRUPOLE PAIRING FORCE. Bes, D. R.; Dussel, G. G.; Gratton, J. (Univ. of Buenos Aires). pp 499-501 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.
The effects of the quadrupole pairing force were analyzed in superconducting nuclei. An important fraction of the enhancements in matrix elements of the specific operators is already produced by the usual quadrupole force. However, the ground-state correlations of the two forces are very different and tend to disappear when both components are present. (auth)

20741 BAND MIXING OF THE ROTATIONAL AND THE $K = 0^+$ EXCITED LEVELS IN DEFORMED EVEN NUCLEI. Mikoshiba, Osamu (Tokyo Univ.); Yoshida, Shiro; Udagawa, Takeshi; Sheline, Raymond K. pp 504-8 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.
A Hamiltonian describing the $\Delta K = 0$ particle-rotation interaction, which includes the β vibration-rotation interaction, is obtained by taking into account the effects of the rotation on the pairing and quadrupole correlations in nuclei within the cranking model. With this Hamiltonian, the mixing effects of the $K = 0^+$ excited bands on the ground-state rotational energies are investigated. (auth)

20742 SHELL-MODEL CALCULATIONS. Lawson, R. D.; Soper, J. M. (Argonne National Lab., Ill.). pp 511-20 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.
The results that emerge from various characterizations of the residual two-body force are discussed. First, one can parametrize the force in terms of its matrix elements. This approach leads to results in excellent agreement with experiment. On the other hand, although one can fit and predict spectra by assuming a pure configuration assignment, there is no guarantee that large configuration impurities are absent. A second approach is to use the reaction matrix computed from the interaction between free nucleons. The computed matrix elements are quite similar to those deduced from the two-body matrix elements fitted to the data. However, small differences get magnified when the many-nucleon shell-model calculation is carried out. Thus the agreement between calculation and experiment is less dramatic in the many-nucleon case than in the two-particle nucleus. Alternatively, one can look for a force of simple form. To this end, the relative s-state interaction or the surface delta force leads to predictions in fairly good agreement with experiment. The success of these simple forces rests on the fact that they are specifically designed to take care of the dominant part of the residual force—the interaction in relative s states. (auth)

20743 SURFACE DELTA INTERACTION AND NUCLEAR DEFORMATIONS. Moszkowski, S. A. (Univ. of California, Los Angeles). pp 544-6 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.
The nonspherical part of the nuclear one-body potential can be generated by a density distribution of the same geometry if the two-body interaction is a surface delta interaction (SDI) of a uniquely specified strength. The SDI derived in this way has a coupling strength $20A^{-1}$ MeV in fair agreement with the strength $25A^{-1}$ MeV deduced by comparison with experimental data. (auth)

20744 SHELL-MODEL DESCRIPTION OF ROTATIONAL STATES. Danos, M.; Gillet, V. (CEN de Saclay, Gif-sur-Yvette, France). pp 547-9 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.
A good angular momentum single configuration wave function which maximizes the correlations between protons and neutrons is proposed. Its elementary excitations are computed with two-body forces and lead to a simple picture of the rotations in nuclei. (auth)

20745 STRUCTURE OF sd-SHELL NUCLEI. Arima, A.; Akiyama, Y.; Horiuchi, H.; Inoue, T.; Sebe, T. (Tokyo Univ.). pp 554-7 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.
A number of results of the shell-model calculations in the sd-shell region are reported. The weak coupling model of the four-particle–four-hole states in ^{16}O is proposed to explain the nature of excited states in ^{16}O. It is found that the ground-state rotational band of ^{20}Ne can be explained very well by the calculation. Further calculations on ^{21}Ne, ^{22}Ne, and ^{22}Na are being carried out. (auth)

20746 TWO-NEUTRON TRANSFER REACTIONS AND NUCLEAR MODELS. Vervier, J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). pp 558-61 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.
The experimental data from the (p,t) reaction on the nickel isotopes and the (t,p) reaction on ^{16}O and ^{40}Ca are compared with the predictions from various nuclear models. It is shown that these two-neutron transfer reactions could provide a valuable tool to test the wave functions proposed for the levels involved. (auth)

20747 NUCLEAR BINDING ENERGIES AND COUPLING SCHEMES. Banerjee, M. K. (Univ. of Maryland, College Park); Levinson, C. A.; Bassichis, W. H.; Ripka, G. pp 569-72 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.
A binding energy formula for nuclei is presented based on a monopole model for the two-body nuclear force. The strengths of the various central force exchange components are evaluated from binding energies in the sd shell and are found to be $M = -2.65$ MeV, $B = -0.7$ MeV, $H = -0.35$ MeV, and $W = -0.8$ MeV. The $4n + 2$ and $4n + 4$ type nuclei clearly require a pairing energy correction of 0.8 MeV before consistency with the model can be obtained. (auth)

20748 RANDOM PHASE APPROXIMATION AND A NEW RENORMALIZATION EFFECT OF THE FORCE-STRENGTH IN COLLECTIVE EXCITATIONS. Yamamura, Masatoshi (Kyoto Univ.); Marumori, Toshio; Tokunaga, Akira. pp 573-6 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.
By using the perturbation theory starting with the solutions under the random phase approximation, the correction to this approximation is evaluated. The results show that the correction is unexpectedly large (in the region of "phonon" energy in which is considered). To keep the "phonon" picture, thus one is forced to make a renormalization of the force strength to include such effects effectively. (auth)

20749 PAIRING PLUS MONOPOLE INTERACTIONS IN A SOLVABLE MODEL. Agassi, D.; Lipkin, H. J. (Weizmann Inst. of Science, Rehovoth, Israel). pp 577-9 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.
A model which can be solved exactly for large numbers of particles by group theoretical methods also has the following interesting features: a transition from "spherical" to "deformed" states as the number of particles is increased, with the associated transition from a seniority coupling scheme to a "deformed" coupling scheme; collective monopole oscillations which can be treated by RPA; and approximate Hartree-Fock and BCS solutions which can be compared with exact solutions. (auth)

20750 BOSON DESCRIPTION OF FERMION SYSTEMS. Soerensen, Bent (NORDITA, Copenhagen). pp 580-3 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.
The convergence of boson expansions of fermion pair operators as first suggested by Beliaev and Zelevinsky is discussed, and a comparison is made with exact solution for four particles in a

degenerate j = $^{15}/_{2}$ shell interacting via pairing plus quadrupole force. (auth)

20751 NUCLEON–NUCLEON SCATTERING. Bryan, R. A. (Univ. of California, Livermore). pp 603-13 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

The presentation is limited to the so-called "pole models" for nucleon-nucleon scattering. The essential feature of these models is the ability to account for the gross structure of the N-N amplitude using just the Born, or one-meson-exchange, terms of the π, η, ρ, and ω mesons, provided the Born term of a T = O, J = O^+ meson, or equivalent effect, is included. An equivalent effect might be a T = O S-wave dipion, with which the scalar meson communicates. There is as yet no conclusive experimental evidence for a scalar meson or dipion in the desired mass range, 400 to 600 MeV, but there is some evidence for a scalar meson near 700 MeV. Some prescription is required to generate the scattering amplitude, since it is complex whereas the Born terms are real. Three methods have been proposed: the Schroedinger equation model, the partial-wave dispersion relation model, and the "geometric unitarization" model. By and large, coupling constants determined by these models are consistent with determinations from other experiments or from higher symmetry schemes. Certain applications of the pole models are discussed, such as to infinite nuclear matter, N-N bremsstrahlung, and N-$\bar{N}$ scattering, and bound states. (auth)

20752 OBEP INTERACTION AND NUCLEAR MATTER. Preston, M. A.; Kiang, D.; Yip, P. (McMaster Univ., Hamilton, Ont.). pp 654-6 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

The velocity-dependent nucleon-nucleon potential obtained from the exchange of several mesons was found to give reasonable agreement with both the two-nucleon data and the properties of nuclear matter. (auth)

20753 HARTREE-FOCK CALUCLATIONS OF FINITE NUCLEI. Baranger, M. (Carnegie Inst. of Tech., Pittsburgh). pp 659-73 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

The application of the Hartree-Fock method to spherical nuclei is briefly discussed with emphasis on the selection of appropriate potentials. (D.C.W.)

20754 NUCLEON-NUCLEON POTENTIAL WITH A SOFT CORE IN THE ENERGY REGION 0.17 TO 310 MeV. Ulehla, I.; Bystricky, J.; Lehar, F. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 687-91 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

Nucleon–nucleon potentials with a soft core, giving a good description of the energy dependence of the nonmixing phase shifts in elastic pp and np scattering, are found. However, at low energies the simultaneous description of pp and np scattering in the $^1S_0$ state with the help of a single potential is in disagreement with the experimental data. (auth)

20755 NUCLEON–NUCLEON INTERACTION CONSISTENT WITH EXPERIMENT AND THE BOSON-EXCHANGE THEORY OF NUCLEAR FORCES. Lomon, Earle; Feshbach, Herman (Massachusetts Inst. of Tech., Cambridge). pp 692-3 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

Nucleon–nucleon data were fitted by a boundary condition model interaction in which the external potentials are given by field-theoretic forms arising from the one- and two-pion exchange, ρ, ω, and η exchange. Good fits were obtained for nucleon laboratory energies below 350 MeV, which are comparable with the best phenomenological fits. The optimum values of the boson–nucleon coupling constants and masses correspond to their known physical values as determined by other experiments. (auth)

20756 SYMMETRY ENERGY AND THE COMPRESSIBILITY OF NUCLEAR MATTER. Razavy, M.; Chiang, C. C. (Univ. of Alberta, Edmonton). pp 698-9 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

The diagonal elements of the nuclear reaction matrix and the effective (long-range) potential are determined from the binding energy and the density of nuclear matter. This effective interaction, together with the singlet even and the triplet odd states phase shifts, have been used to calculate the symmetry energy E_s, the compressibility K, and the rearrangement energy E_R. With the assumption that the long-range part of the interaction is given by the Brueckner-Gammel-Thaler potential, the numerical values of these quantities are found to be E_s = 22, E_R = 11.7, and K = 239 MeV. (auth)

20757 SELF-CONSISTENT FIELD CALCULATION FOR THE NUCLEAR SURFACE. Kohler, H. S. (Rice Univ., Houston, Tex.). pp 700-2 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

A self-consistent field calculation for the nuclear surface was made. A K-matrix was derived by the separation method and was expanded to obtain an effective mass approximation. Some parameters were adjusted to give proper saturation for the infinite system. Reasonable agreement with experiment is obtained for surface depth and surface energy. The calculations favor somewhat a soft core and a relatively low density (0.17 nucleons/F^3). (auth)

20758 COLLECTIVE PARTICLE HOLE STATES WITH REALISTIC NUCLEAR FORCES. Barrett, B. R.; Walecka, J. D. (Stanford Univ., Calif.). pp 703-5 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

The supermultiplet of giant resonances was studied by diagonalizing the particle-hole interaction in a finite basis. The particle–particle interaction was determined by approximately solving the Bethe-Goldstone equation for three realistic nucleon–nucleon potentials. Since for ^{4}He there are more equations than theoretical parameters, sum rules which check the consistency of the calculation and give predictions were obtained. Results are also given for ^{12}C and ^{16}O. (auth)

20759 A FORCE SUITABLE FOR DEFORMATION AND HARTREE-FOCK CALCULATIONS IN LIGHT NUCLEI. Hughes, D. J.; Sprung, D. W. L.; Volkov, A. B. (McMaster Univ., Hamilton, Ont.). pp 710-13 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

A simple, density-dependent, central force, especially suitable for deformation and/or Hartree-Fock calculations, is obtained by consideration of "realistic" forces and the results of nuclear matter calculations. The main criteria for determining the force are the zero-energy scattering parameters and the experimentally observed size and binding energies of light closed-shell nuclei. (auth)

20760 SECOND ORDER CONTRIBUTION TO THE BINDING ENERGY OF CLOSED SHELL NUCLEI WITH THE TABAKIN POTENTIAL. Pal, M. K.; Svenne, J. P.; Kerman, A. K. (Massachusetts Inst. of Tech., Cambridge). pp 714-17 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

Hartree-Fock calculations were performed previously on the binding energy of finite nuclei using the separable potential of Tabakin. In this paper an evaluation of the second-order correction to the binding energy of ^{16}O is reported. Including the second-order terms, a binding of 6.7 MeV per particle is obtained. (auth)

20761 COMPOUND NUCLEUS. Vogt, Erich (Univ. of British Columbia, Vancouver). pp 748-61 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.
See CONF-660906.

The description of nuclear reactions by means of framework based on the physical ideas of the compound nucleus has enjoyed remarkable success. The usefulness of the compound nuclear ideas has grown with increasing information about nuclear interactions and shapes and conservation laws; it has survived the advent of various nuclear reaction mechanisms more easily described by the Born approximation. The range of validity of the compound nucleus is illustrated with the following two extreme cases: the phenomenological description of reactions involving narrow resonance lines, as in the alpha decay of heavy nuclei or in the low-energy reactions of interest for astrophysics; and the accurate prediction of average cross sections and cross-section fluctuations in the very short-lived compound systems at high energy. These examples are used to discuss the physical content of various alternative reaction theories, the distinguishability of compound nuclear processes from other processes,

and the rather indirect contribution of compound nuclear reactions to nuclear structure studies. (auth)

20762 NUCLEAR REACTIONS BY SEQUENTIAL SCATTERINGS: DIRECT REACTIONS AND PARTIAL NUCLEAR LEVEL DENSITIES. Griffin, James J. (Univ. of Maryland, College Park). pp 778-82 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The possibility of studying partial level densities by measuring the energy dependence of average cross sections for direct reactions is pointed out. The (α,p) reaction is discussed, in particular; and a preliminary comparison of calculation and experiment is presented as an illustrative example. (auth)

20763 NUCLEAR CROSS SECTION FLUCTUATIONS AND RANDOM MATRICES. Krieger, Theodore J. (Brookhaven National Lab., Upton, N. Y.). pp 789-91 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The method of random matrices is applied to the analysis of nuclear cross-section averages and fluctuations in the continuum region. A generalization of Dyson's "orthogonal" ensemble of random unitary symmetric matrices is postulated as the underlying statistical ensemble from which averages and variances of nuclear reaction cross sections may be calculated. Analytical results in the asymptotic limit $N \gg 1$ are presented. (auth)

20764 EXACT DISTRIBUTIONS OF THE COMPOUND-NUCLEUS LEVEL WIDTHS. Ullah, Nazakat (Tata Inst. of Fundamental Research, Bombay). pp 812-14 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The invariance hypothesis is used to derive exact expressions for multilevel and multichannel distributions of the reduced-width amplitudes, which are valid for all dimensions of the random orthogonal matrix. These distributions are used to predict various correlations of the compound–nucleus level widths. In the limit of large dimensions, the distribution reduces to the one obtained using the assumption of level independence. (auth)

20765 FLUX CONSERVATION IN RESONANCE REACTIONS. Moldauer, P. A. (Argonne National Lab., Ill.). pp 815-18 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Some simple analytic models of the R matrix are used to obtain exact multilevel expansions of the S matrix. Among the results is the following relation between channel transmission coefficients and S-matrix average channel width to spacing ratios: $T_c = 1 - \exp(-2\pi\overline{\Gamma}_c/D)$, which is violated only when direct reactions or channel-channel resonance correlations are introduced. Consequently, $\overline{\Gamma}_c/D$ may assume arbitrarily large values. (auth)

20766 DEFORMATIONS IN LIGHT NUCLEI. Ripka, Georges (CEN, Saclay, France). pp 833-45 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Hartree-Fock calculations were performed for a number of relatively light nuclei considering both the case in which each orbit belongs to one major shell and the case of major shell mixing. The deformations of light nuclei were investigated in detail. (D.C.W.)

20767 SPECTROSCOPIC FACTORS FOR FORBIDDEN TRANSITIONS. Kurath, Dieter (Argonne National Lab., Ill.). pp 861-2 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Spectroscopic factors are calculated for transfer of 1f nucleons in some 1p-shell nuclei. The wave functions are determined by fitting observed E2 matrix elements. The particular example of pickup from ^{12}C contains a strong j dependence which is not observed in experiments. Therefore simple single-nucleon transfer does not seem to be an adequate mechanism. (auth)

20768 MAJOR SHELL MIXING IN DEFORMED p-SHELL NUCLEI. Stephenson, G. J. Jr. (California Inst. of Tech., Pasadena). pp 906-7 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The f-wave reduced width for single nucleon emission to the ground state of ^8Be from the $5/2^-$ states of ^9Be and ^9B was calculated from the Nilsson model. The calculated value is well above the upper limit given by Wilkinson, Sample, and Alburger for ^9B, but in reasonable agreement with the value given by Christensen and Cocke for ^9Be. (auth)

20769 SPECTATOR POLES IN FEW-NUCLEON SYSTEMS. Mollenauer, J. F. (Bell Telephone Labs., Inc., Murray Hill, N. J. Brookhaven National Lab., Upton, N. Y.); Donovan, P. F.; Zupancic, C.; Boyd, D. P.; Bredin, D. J.; Sellschop, J. P. F.; Parker, P. D. pp 983-6 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

"Giant" spectator peaks were observed in the coincident energy spectra of particles emitted in three-body-breakup reactions of a variety of few-nucleon systems. Under certain conditions, these peaks comprise the bulk of the observed reaction cross section. A simple plane-wave knockout theory provides a surprisingly good fit to the data. (auth)

20770 THEORY OF FEW-NUCLEON SYSTEMS. Amado, R. D. (Univ. of Pennsylvania, Philadelphia). pp 994-1005 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

Recent theoretical developments of a formal and technical nature in the three-body problem are described. In particular, the device of representing the two-body force by a sum of separable interactions makes possible exact calculations in the three-body system. The results of such calculation for the triton binding energy, n-d scattering lengths, n-d scattering to 14 MeV, and the reaction $n + d \rightarrow 2n + p$ are reviewed. They show that the major features of the three-nucleon system can be understood in terms of simple low-energy s-wave, spin-dependent, nucleon–nucleon forces and exact treatment of three-body effects. The tensor force is needed in the triton binding energy, while the triton form factors show the need of a short-range repulsion at large momentum transfers. The calculations of deuteron breakup are not good enough to settle the question of the n-n scattering length, but they do shed considerable doubt on the approximate method used in the past to extract this number from the data. (auth)

20771 NUCLEAR THREE-BODY PROBLEM WITH SEPARABLE NONLOCAL INTERACTION WITH HARD CORE: BINDING ENERGY OF ^3H. Borysowicz, J.; Dabrowski, J. (Inst. for Nuclear Research, Warsaw). pp 1033-5 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The problem of the ground state of the system of three nucleons interacting via a separable nonlocal two-body potential containing a repulsive hard shell of radius r_c is reduced to a system of homogeneous integral equations for six functions of one variable. The calculated ground-state energy of ^3He is -12.3 MeV for $r_c = 0$ and -9.1 MeV for $r_c = 0.4F$. (auth)

20772 THE SPIN DEPENDENCE OF ONE-BODY POTENTIALS AND p–^{3}He ELASTIC SCATTERING. Tanifuji, Makoto (Rice Univ., Houston, Tex.). pp 1039-41 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

The spin dependence of one-body potential for elastic scattering of nucleons from a spin $1/2$ nucleus is studied. In particular, the polarizations of the nucleon and the nucleus and p-wave phase shifts are discussed for various assumptions of the potential spin dependence. The method is applied to the p-^{3}He elastic scattering. (auth)

20773 PROGRESS REPORT ON NUCLEAR PHYSICS. Mottelson, B. R. (NORDITA, Copenhagen). pp 1081-9 of International Nuclear Physics Conference, Gatlinburg, Tennessee. Becker, Richard L. (ed.). New York, Academic Press, 1967.

See CONF-660906.

In the present situation with the explosive increase in the power of the experimental tools, together with the growing understanding of the richness and subtility of the nuclear phenomena, the field affords an exciting and challenging prospect. An attempt is made to define and discuss some aspects of this present prospect. (auth)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 19004, 19194, 19513, 19589, and 19672.

20774 (AAEC/E-179) ECONOMICS OF THE H.T.G.C.R. FUEL CYCLE. PART 2. FUEL CYCLE COST STUDIES. Hubery, R. W.; Baillie, M. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). June 1967. 24p. Dep.

The use of beryllium oxide as a moderator in a high temperature gas-cooled pebble bed reactor system which has been under study by the Commission incurs penalties due to its relatively high cost and the difficulty of reprocessing the fuel. The basic open and closed fuel cycles for such a system and the definitions of the parameters affecting the cost of each cycle are described. Analytical relationships are developed for each cost component to facilitate calculations over a wide range of reactor design variables. This approach is of value during initial optimization studies on a reactor concept. Calculations based on a 200 MWe design show that, using optimistic assumptions, recycle of spent fuel would be economically attractive for installed capacities greater than 800 MWe. (auth)

20775 (AECL-3002) REACTIVITY EFFECT OF MODERATOR VOIDS IN A CANDU LATTICE. Green, R. E. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan. 1968. 26p. Dep. CFSTI. CAN $1.00.

Experiments were performed in ZED-2 to determine the reactivity effect of voids in the moderator of a CANDU-type lattice. From measurements with a small void located at various positions in the lattice, it was possible to separate the flux-dependent and gradient-dependent effects and to derive constants that may be used to determine the reactivity effect of a similar void in CANDU. The experiments showed that in ZED-2 a moderator void produces a negative reactivity change at all points in the reactor. The absolute value was larger near the edges than at the center in ZED-2, but the effect is predicted to be greatest at the center of the CANDU reactor. This is due to the influence of the flux gradient which is much larger in ZED-2 than in CANDU. Measurements with a very large void (simulating removal of all moderator from the central cell) gave a much larger negative reactivity effect than that predicted from the superposition of many small void effects. This difference is believed to be partly due to neutron streaming in the larger void, an effect that should be less in a large power reactor. (auth)

20776 (APDA-CFE-16) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT, NOVEMBER 1967. Costello, R. H. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). Jan. 1968. Contract AT(11-1)-865. 45p. Dep. CFSTI.

The unidentified object removal plans are described. The plans consist of two different methods: cutting up the object and retrieving it through the support plate holes; and retrieving the object intact through the 14-inch Na inlet line. The development of cut-up tools and manipulator devices is described. (D.C.C.)

20777 (BNWL-574) A STUDY OF HYDRAULIC AND NUCLEAR STABILITY OF BOILING WATER PARALLEL FLOW CHANNEL REACTOR SYSTEMS. Worden, J. R.; Rowe, D. S.; Dionne, P. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1968. Contract AT(45-1)-1830. 173p. Dep. CFSTI.

Stability of a boiling, light water cooled, heavy water-moderated reactor has been studied by simulation on an analog computer. The model consists of a two-region reactor with coupling between the nuclear kinetics and hydrodynamics. Those parts of the reactor system external to the recirculating loop, such as turbines and feedwater pumps, were approximated by appropriate control functions. The simulation provides valid results over a range in power level from about $\frac{2}{3}$ nominal up to the threshold of parallel channel instability. The reactor has an overall positive power coefficient of reactivity and requires automatic control. It is concluded from the study that the system is stable under a large variety of operating conditions, confirming results of design studies by AECL personnel. (auth)

20778 (BNWL-624) PLUTONIUM UTILIZATION PROGRAM ANNUAL REPORT, FISCAL YEAR 1967. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1967. Contract AT(45-1)-1830. 270p. Dep. CFSTI.

Activities in the program for the development of technology for safe and economical recycle of plutonium fuel in power reactor systems are summarized. Separate abstracts were prepared for each of the five sections included. (H.D.R.)

For abstracts of individual sections see: 19669, 19670, 20779, 20780, and 20905.

20779 (BNWL-624, pp 3.1-159) REACTOR PHYSICS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Experiments were conducted in the Critical Approach Facility and the Plutonium Recycle Critical Facility to investigate the detailed physics properties of plutonium-fueled reactor systems. Measurements have been made using UO_2-2 wt % PuO_2 rods in H_2O moderator. Experiments were conducted at lattice spacings covering the range of moderator to PuO_2-UO_2 volume ratios of 0.61 to 9.7 and the plutonium contained either 8, 16 or 24% ^{240}Pu. The results included critical masses, bucklings, flux and power distributions, reactivity coefficients, kinetic parameters, and control rod worths. The PCTR is being used for evaluating the effect on reactivity of finite PuO_2 particles in UO_2 and for obtaining additional data on water lattices not obtainable from other facilities which are required for further evaluation of analysis methods. The initial results of the PuO_2 particle size experiments indicate that the reactivity decreases as the size is increased from 100 μ to 350 μ for the fuel composition used (2.0 wt % PuO_2, 8.05 wt % ^{240}Pu). The design of the first experiment in the water tank is complete and will contain PuO_2-UO_2 fuel on a 1.0 in. lattice pitch. A large scale burnup experiment has been initiated in the D_2O-moderated Plutonium Recycle Test Reactor using 19-rod clusters of UO_2-2 wt % PuO_2 rods. The first phase of the experiment has been completed and consisted of an extensive set of tests at zero power during the initial loading of the core. A series of power tests designed primarily to verify predicted operational characteristics of the reactor were conducted when the loading was completed. An irradiation experiment was conducted in the Experimental Boiling Water Reactor at Argonne National Laboratory. This experiment is part of the joint ANL-PNL program to demonstrate the utilization of plutonium in a boiling H_2O power reactor and to obtain useful physics information on the behavior of a plutonium fuel in such a reactor system. At three stages of burnup a series of rods were removed from the plutonium zone for nondestructive and destructive analysis. The series of rods contained Al-Pu, natural UO_2, and UO_2-PuO_2 fuels. In addition, the fuels which contained plutonium differed in their ^{240}Pu concentration. Some of the rods are selected from positions in the core so that the spatial distribution of burnup can be obtained from the nondestructive and destructive analysis. Fuel rods removed from selected locations in the EBWR and from past and present experiments in the PRTR are both nondestructively and destructively analyzed to obtain fission and fuel concentration and isotopic composition. From these data effective cross section ratios are derived for use in evaluating burnup analysis methods. New techniques for this purpose using multi-parameter, non-linear regression methods have been developed and applied to data from four sets of irradiated Al-Pu samples. The PNL Gamma Scanner has been improved and continues to be used for the nondestructive analysis. Information on the physics characteristics of pressurized water power reactor systems which were obtained during the Saxton plutonium program is compared to results obtained with zero, one, and two-dimensional diffusion theory methods. The conclusion reached is that a one-dimensional cylindrical model of the reactor seems adequate from the standpoint of reactivity calculations for single zone lattices. Analytical survey studies have been performed to provide information on the physics characteristics for various reactor systems of interest. It is shown that the UO_2-4 wt % PuO_2-H_2O cores which were studied would be undermoderated and that the characteristic parameters such as η, f, and p play an important role in the physics behavior of these cores. A survey study was conducted to determine the approximate magnitude of various reactivity coefficients for UO_2-PuO_2 fueled light water reactors. Calculations were also performed to determine the reactor characteristics of thorium loadings in D_2O moderator. The feasibility of the thorium loading in the PRTR was determined either as a batch core or as a driver region for a UO_2-PuO_2 core. The physics characteristics of metallic fuel and of ceramic fuels were investigated along with the variation in rod size in thorium enrichment. Slow neutron inelastic scattering cross sections have been reported for H_2O and D_2O. The double differential cross section and corresponding Egelstaff scattering law have been obtained from measurements for room temperature H_2O and D_2O and for H_2O of five degrees below its freezing point using the Battelle Rotating Crystal

time-of-flight Spectrometer. In addition, results of measurements for H_2O at 95°C using the Battelle Triple-Axis Spectrometer have been reported. An extensive evaluation of the RBU Monte Carlo Code has been completed. Results of this evaluation indicate that the RBU Monte Carlo code is free of gross program errors and can be used reliably for reactor physics calculations. Knowledge of the Legendre moments of moderator scattering cross sections is of particular importance in the prediction of the thermal neutron spectrum of plutonium fueled reactors. Based on the Egelstaff-Schofield formalism, two methods for calculating scattering moments for moderators have been developed and programmed on the computer. A model for water is being evaluated using available experimental data. Several computer codes have been adapted, modified, or improved for use in the physics programs. The RBU Monte Carlo code has been thoroughly tested and appears to be working satisfactorily. The ZODIAC-2 burnup code was modified and enlarged to increase its burnup capabilities. The HRG (Hanford Revised GAM) code spectrum model used in resonance integral calculations was improved. Several special purpose codes have been developed. Assistance was provided to Brookhaven National Laboratory in preparing nuclear data for the ENDF/B. Data were furnished for the ten isotopes which Battelle accepted responsibility to evaluate as a member of the Cross Section Evaluation Working Group. Adaption of the ENDF/B system to the local UNIVAC 1108 is in progress. Theoretical studies have been directed toward developing a mathematical physics model which accurately predicts the observed physics behavior of power reactor systems. A measure of the validity of the mathematical model is obtained by comparing measured and calculated integral parameters such as reactor multiplication and effective cross sections. Comparisons have been performed for numerous plutonium and/or uranium fueled H_2O lattices. Comparisons of flux and power densities, reactivity coefficients, kinetic parameters, and effective cross section ratios, have also been made. The results of the comparisons show that in many cases the calculational techniques need to be refined. (auth)

20780 (BNWL-624, pp 4.1-16) PLUTONIUM UTILIZATION STUDIES. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The economic incentives for reoptimizing the lattices of reactors originally designed for uranium fuel to utilize plutonium fuel are examined. Results are presented for three methods of reactor modification: reduced fuel density, reduced rod size, and increased lattice pitch. Power distribution problems that arise when a reactor is partially reloaded with plutonium are discussed. A general description of input requirements and results of a sample design problem for the REPP code for optimum utilization of plutonium in thermal water-moderated power reactors are presented. (H.D.R.)

20781 (BNWL-693) COMPUTER RETRIEVAL OF CSE MULTIPLEXER DATA. Weissenberger, W. R.; Wells, E. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1967. Contract AT(45-1)-1830. 39p. Dep. CFSTI.

Descriptions of PDP-7 computer programs to allow the retrieval of multiplexer data from the Containment System Experiment are given. Program listings and flow-diagrams of the programs are included. (auth)

20782 (BNWL-SA-1501) SENSITIVITY OF REACTIVITY CHARACTERISTICS TO CROSS SECTION UNCERTAINTIES FOR PLUTONIUM-FUELED THERMAL SYSTEMS. Jenquin, U. P.; Uotinen, V. O.; Heeb, C. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 29, 1968. Contract AT(45-10)-1830. 18p. (CONF-680307-7). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

Uncertainties in reactivity characteristics due to cross-section uncertainties are estimated for Pu-fueled thermal reactor systems. The reactivity characteristics considered are: reactor multiplication, B worth, moderator and fuel temperature coefficients, and void coefficient. Under the assumptions used in the analysis, appreciable uncertainties in reactor multiplications are due to uncertainties in the values of the resonance integrals and the normalizations of the thermal cross sections, as well as uncertainties in the shape of the ^{239}Pu thermal cross sections. Uncertainties in moderator coefficients are due mainly to uncertainties in the shape of the ^{239}Pu thermal cross sections. (auth)

20783 (DOCKET-50206-1) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT NO. 1. Final Engineering Report and Safety Analysis, Amendment 10, Suppl. 1. (Southern California Edison Co., Camp Pendleton, Calif. San Diego Gas and Electric Co., Calif.). Apr. 17, 1966. 159p. (NYO-3270-2(Suppl.1)). Dep. CFSTI.

The emergency power system for the San Onofre Power Reactor is described in detail. The surveillance program for the reactor vessel is discussed. Peak heat flux and power distribution data are shown. Effects of DNB on rod programming are analysed. The efficiency of the ion exchangers in the waste disposal system is considered. Containment isolation values are listed with pertinent information on each; recirculation isolation points are listed. Pressure transients following the double ended rupture of a primary coolant pipe are analysed. A loss-of-coolant accident concurrent with failure of the safety injection system is considered in some detail. An evaluation of fission product release is given. Boric acid additions to the volume control system are evaluated. (M.L.S.)

20784 (DOCKET-50206-2) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT NO. 1. Final Engineering Report and Safety Analysis, Amendment 11, Suppl. 2. (Southern California Edison Co., Camp Pendleton, Calif. San Diego Gas and Electric Co., Calif.). May 26, 1966. 50p. (NYO-3270-2(Suppl.2)). Dep. CFSTI.

Detailed information on the surveillance program for the San Onofre Power Reactor pressure vessel is given. A complete list of revised containment isolation values and process flow diagrams is given. (M.L.S.)

20785 (DOCKET-50266-1) POINT BEACH NUCLEAR PLANT, [UNIT NO. 1]. Preliminary Facility Description and Safety Analysis Report, Suppl. 1. (Wisconsin Michigan Power Co., Appleton, Wis.). Dec. 20, 1966. 328p. Dep. CFSTI.

Information on the proposed containment for the Point Beach Power Reactor, Unit I, is given. This includes: a discussion of proposed design loadings; an analysis and details of the tendon, liner, and penetration design; the basis for selection of construction materials and a description of construction techniques; and initial tests and inservice surveillance. Stress analysis procedures are detailed. Diagrams of vessel loadings for dead and live loads, winter thermal loads, prestress, internal pressure, wind, and earthquake loads are shown. Test data for the Freyssinet and BBRV tendon systems; stress-strain data are shown; static and dynamic data are given. Diagrams of equipment locations are included. Design criteria for prestressed concrete containment vessels are delineated. Quality control procedures for field welding are given. Possibilities and consequences of turbine-generator overspeed are analyzed. (M.L.S.)

20786 (DOCKET-50266-2) [POINT BEACH NUCLEAR PLANT, UNIT NO. 1]. Provisional Construction Permit No. CPPR-32, Amendment 1. (Wisconsin Michigan Power Co., Appleton, Wis. Wisconsin Electric Power Co., Milwaukee). Dec. 13, 1967. 5p. Dep. CFSTI.

An administration action, reflecting a change in the ownership of the facility, is presented. (M.L.S.)

20787 (DOCKET-50266-3) POINT BEACH NUCLEAR PLANT, [UNIT NO. 1]. Preliminary Facility Description and Safety Analysis Report], Suppl. 2. (Wisconsin Michigan Power Co., Appleton, Wis.). Feb. 13, 1967. 135p. Dep. CFSTI.

An analysis of possible component failure under accident conditions in Point Beach Power Reactor, Unit I, is given. Radiolytic production of hydrogen under accident conditions is considered; associated hazards are evaluated. Turbine rotor failures are considered. Design criteria for containment piping penetrations are given; all penetrations are listed. Assurance of emergency power system availability is discussed. Effects of tornado loadings on the containment structure are analyzed. Fission product inventory under maximum burnup conditions is given. Results of a sensitivity study on effects of changes in methyl iodide formation during a hypothetical accident are shown. (M.L.S.)

20788 (DOCKET-50266-4) [POINT BEACH NUCLEAR PLANT, UNIT NO. 1]. [Preliminary Safety Analysis Report], Suppl. 3. (Wisconsin Michigan Power Co., Appleton, Wis.). Mar. 20, 1967. 56p. Dep. CFSTI.

Seismic design and loadings of the Point Beach Power Reactor, Unit I, containment vessel are analyzed; earthquake response spectra are given. The efficiency of the emergency core cooling system, in event of an accident, is evaluated. Test pile data are presented. (M.L.S.)

20789 (DOCKET-50266-5) [POINT BEACH NUCLEAR PLANT, UNIT NO. 1]. [Preliminary Safety Analysis Report], Suppl. 4. (Wisconsin Michigan Power Co., Appleton, Wis.). Apr. 20, 1967. 34p. Dep. CFSTI.

Information on the containment system for Point Beach Power Reactor, Unit I, is given. Seismic design of Class I components is considered. Plant safety features are discussed. (M.L.S.)

20790 (DOCKET-50266-6) [POINT BEACH NUCLEAR PLANT, UNIT NO. 1]. [Preliminary Safety Analysis Report], Addendum to Suppl. 4. (Wisconsin Michigan Power Co., Appleton, Wis.). May 5, 1967. 7p. Dep. CFSTI.

Cross references to answers of ACRS subcommittee questions are given. (M.L.S.)

20791 (DOCKET-50266-7) POINT BEACH NUCLEAR PLANT, [UNIT NO. 1]. Preliminary Facility Description and Safety Analysis Report, Vol. 2. (Wisconsin Michigan Power Co., Appleton, Wis.). Aug. 31, 1966. 477p. Dep. CFSTI.

Information on Point Beach Power Reactor, Unit I, is presented under the following broad topics: Summary Description; Site and Environment; Reactor; Reactor Coolant System; and Containment System. (M.L.S.)

20792 (DOCKET-50266-8) POINT BEACH NUCLEAR PLANT, [UNIT NO. 1]. Preliminary Facility Description and Safety Analysis Report, Vol. 3. (Wisconsin Michigan Power Co., Appleton, Wis.). Aug. 31, 1966. 448p. Dep. CFSTI.

Information on Point Beach Power Reactor, Unit I, is given under the following broad topics: Engineered Safeguards including containment ventilation, and containment spray systems; Plant Instrumentation and Control; Electrical System; Auxiliary and Emergency Systems including chemical and volume control, auxiliary coolant, sampling, fuel handling and facility service systems; Strain and Power Conversion System; Radioactive Waste and Radiation Protection; and Safety Evaluation including core and coolant boundary and standby safeguards. A site evaluation report is appended; soil coring data are shown. The computer printout for the wind diffusion program is included. Seismic design criteria are tabulated. A detailed seismicity analysis is given. (M.L.S.)

20793 (DOCKET-50272-6) SALEM NUCLEAR GENERATING STATION (FORMERLY BURLINGTON NUCLEAR GENERATING STATION). Preliminary Facility Description and Safety Analysis Report, Amendment 5, Part B, Vol. 5. (Public Service Electric and Gas Co., Newark, N. J.). Mar. 14, 1968. 262p. (DOCKET-50311-6). Dep. CFSTI.

Compliance of the design of the Salem Power Reactor to the General Design Criteria is outlined. All vessels belonging to the Class I seismic classification are tabulated. Revised pages of the original PSAR are included. (M.L.S.)

20794 (DOCKET-50275-4) NUCLEAR PLANT, DIABLO CANYON SITE. Preliminary Safety Analysis Report, Amendment 1, Suppl. 1. (Pacific Gas and Electric Co., San Francisco, Calif.). July 12, 1967. 130p. Dep. CFSTI.

Wind loading distributions for the Diablo Canyon Power Reactor containment vessel are shown; data are tabulated. The environmental monitoring program is detailed. Radiation protection and radiation sources, in the event of an accident, are discussed. Effects of stresses on the containment vessel are analysed. Quality control standards and testing procedures for cements, concretes, and steels used in reactor construction are given. The reports, Ultimate Strength Criteria to Ensure No Loss of Function of Piping and Vessels Under Earthquake Loading (WCAP-5890), prepared by Westinghouse, are included. (M.L.S.)

20795 (DOCKET-50275-5) NUCLEAR PLANT, DIABLO CANYON SITE. Preliminary Safety Analysis Report, Amendment 2, Suppl. 2. (Pacific Gas and Electric Co., San Francisco, Calif.). July 26, 1967. 210p. Dep. CFSTI.

Design analyses for all Class I equipment for Diablo Canyon Power Reactor are given. Membrane forces resulting from relative influence of individual loadings on the containment vessel are shown in detail. The liner design is analysed. Effects of mechanical and thermal stresses on the containment vessel are analysed. Reactor trip channels are described; functional mode is indicated. The ability of the electric system to supply power to emergency systems in event of an accident is analysed. Effects of a misplaced fuel assembly on steady state and transient conditions in-core are discussed. Thermal shock on primary system components, induced by operation of the safety injection system, is considered. The containment spray system is discussed. (M.L.S.)

20796 (DOCKET-50275-6) NUCLEAR PLANT, DIABLO CANYON SITE. Preliminary Safety Analysis Report, Amendment 3, Suppl. 3. (Pacific Gas and Electric Co., San Francisco, Calif.). Aug. 2, 1967. 350p. Dep. CFSTI.

Additional information on the faulting of the bedrock at the Diablo Canyon Power Reactor site is given; a brief explanation of the site geology is presented. Plant water intake structures are described; intake pumps are evaluated with respect to possible need for protection and operability. Earthquake response spectra are reevaluated in some detail. Containment pneumatic acceptance testing is discussed. Environmental effects on protective and electrical equipment for engineered safety features are analysed. A reactor sensitivity analysis is presented in graphic form; power distributions and DNB ratios are given. Containment vessel penetrations are shown in detailed diagrams; detailed information on values included in the penetration system is tabulated. Radiation exposure at site boundary is shown as a function of leakage from the recirculation loop following an accident. A detailed quantitative discussion is given on the effects that a superheated containment atmosphere would have on heat removal; effects of the spray system are discussed. The analytical model used for estimation of the capability of the containment structure to withstand energy releases without exceeding design pressures is given. A detailed analysis of a coolant loss accident is presented; data are given in tabular and graphic form. A steam line break accident is analysed. The model used in calculating fission product inventory in the reactor coolant during operation is given. Detailed supplementary information on the geology of the Diablo Canyon site is included. (M.L.S.)

20797 (DOCKET-50275-7) [NUCLEAR PLANT, DIABLO CANYON SITE]. [Preliminary Safety Analysis Report], Amendment 4. (Pacific Gas and Electric Co., San Francisco, Calif.). Sept. 11, 1967. 6p. Dep. CFSTI.

Design compliance of Diablo Canyon Power Reactor with the AEC proposed General Design Criteria is outlined; sections pertinent to each criteria are indicated. (M.L.S.)

20798 (DOCKET-50275-8) NUCLEAR PLANT, DIABLO CANYON SITE. Preliminary Safety Analysis Report, Amendment 5, Suppl. 4. (Pacific Gas and Electric Co., San Francisco, Calif.). Oct. 18, 1967. 190p. Dep. CFSTI.

The annual financial report of the Pacific Gas and Electric Company, owners of Diablo Canyon Power Reactor, is included. Supplementary information on the Tsunami studies is given. A history of seismological activities in the Diablo Canyon area is chronicled. The Ultimate Strength Criteria to Ensure No Loss of Function of Piping and Vessels under Earthquake Loading, prepared by the Westinghouse Electric Corporation (WCAP-5890) for pressurized water reactors, are given. (M.L.S.)

20799 (DOCKET-50275-9) NUCLEAR PLANT, DIABLO CANYON SITE. Preliminary Safety Analysis Report, Amendment 6, Suppl. 5. (Pacific Gas and Electric Co., San Francisco, Calif.). Nov. 7, 1967. 205p. Dep. CFSTI.

The objectives of the research and development programs for the Diablo Canyon Power Reactor are discussed. Effects of loss-of-coolant accidents are discussed with respect to fuel element damage. Acceptance testing and quality assurance programs are detailed. Modifications to reactor protection systems are described. Loading combinations, stress and deformation limits, and safety margins for reactor vessel intervals, piping, vessels, and supports are given; data are tabulated. Stress-strain curves for structural materials are given. The reports: Use of Burnable Poison Rods in Westinghouse Pressurized Water Reactors (WCAP-7113) and Experimental Determination of the Departure from Nucleate Boiling in Large Rod Bundles at High Pressure, prepared by Westinghouse, are included. (M.L.S.)

20800 (DOCKET-50275-10) NUCLEAR PLANT, DIABLO CANYON SITE. Preliminary Safety Analysis Report, Amendment 7, Suppl. 6. (Pacific Gas and Electric Co., San Francisco, Calif.). Nov. 9, 1967. 55p. Dep. CFSTI.

Emergency core cooling modifications are described. Additional information in instrumentation and control systems is given. Supply of emergency electrical power, especially to engineered safety systems, is detailed. Detailed analysis of xenon oscillations is given. (M.L.S.)

20801 (DOCKET-50282-4) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, RED WING, MINNESOTA, UNITS 1 AND 2. Facility Description and Safety Analysis Report, Amendment 4. (Northern States Power Co., Minneapolis, Minn.). Feb. 15, 1968. 19p. (DOCKET-50306-4). Dep. CFSTI.

Supplementary information of a general nature is presented on the following: instrumentation and controls, ventilation systems for various structures, various aspects of the containment system, soil damping for earthquake design, and siting conditions. (M.L.S.)

20802 (DOCKET-50282-5) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, RED WING, MINNESOTA, UNITS 1 AND 2. Facility Description and Safety Analysis Report, Amendment 5. (Northern States Power Co., Minneapolis, Minn.). Feb. 28, 1968. 314p. (DOCKET-50306-5). Dep. CFSTI.

Preliminary design and operations parameters for Prairie Island Power Reactor, Units 1 and 2, are tabulated; these are compared with the Robert E. Ginna Power Reactor and Point Beach Power Reactor, Units 1 and 2. Design and engineering criteria are listed. Bases for determination of criteria for storm, flood, and earthquake protection are delineated. Design bases, design loadings, and design analysis of the containment vessel are outlined. A list of containment penetrations is given. The engineered safety systems are described; a list of reactor trips is

included. Integrity of core and internals is evaluated. A coolant loss accident is analyzed; localized thermal effects are examined in detail. The plant performance testing program is outlined. Compliance with the General Design Criteria is tabulated. (M.L.S.)

20803 (DOCKET-50298-7) COOPER NUCLEAR STATION. [Preliminary Safety Analysis Report], Amendment 6. (Consumers Public Power District, Columbus, Nebr.). Mar. 2, 1968. 13p. Dep. CFSTI.

Design criteria for critical piping and structures for Cooper Power Reactor are given; tentative general criteria for evaluation of Class I ductile metallic structures under accident or fault conditions are tabulated. (M.L.S.)

20804 (DOCKET-50300-2) EASTON NUCLEAR STATION. Preliminary Safety Analysis Report, Amendment 2, Suppl. 2, Exhibit B-2. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Mar. 19, 1968. 113p. Dep. CFSTI.

Additional information on geologic, hydrologic, seismologic and foundation characteristics of the site for the Easton Power Reactor is given. Soil core sampling data are shown. Static moduli of elasticity of soils and stress-strain characteristics of shale bedrock are tabulated. Moisture content and grain size of the soils are determined. Seismic design criteria for reactor intervals and Class I structures are given. The method used to anchor the drywell concrete support block to the base slab is described. (M.L.S.)

20805 (DOCKET-50301-2) POINT BEACH NUCLEAR PLANT, UNIT NO. 2. Preliminary Facility Description and Safety Analysis Report, Suppl. 2. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). Mar. 1, 1968. 105p. Dep. CFSTI.

Loading combinations, stress and deformation limits, and safety margins for all Class I structures for Point Beach Power Reactor, Unit 2, are given. Values for stress limits and minimum safety margins are tabulated. Data are presented graphically. Seismic classifications of Class I vessels are tabulated. (M.L.S.)

20806 (DOCKET-50309-5) RECOMMENDED PROVISIONS FOR RESISTANCE TO TANGENTIAL SHEAR FORCES ASSOCIATED WITH EARTHQUAKE LOADING. Structural Design Report. Hansen, Robert J.; Holley, Myle J. Jr.; Biggs, John M. (Stone and Webster Engineering Corp., Boston, Mass.). Jan. 15, 1968. 12p. Dep. CFSTI.

For Maine Yankee Atomic Power Co., Augusta.

The recommended provisions for resistance to tangential shear forces induced by earthquake loading of the containment vessel of the Maine Yankee Power Reactor are given. The use of circumferential and vertical rebars to resist membrane forces is discussed. (M.L.S.)

20807 (DP-1125) ZERO POWER EXPERIMENTS WITH ^{235}U-ENRICHED THORIA AND THORIUM METAL LATTICES FOR THE HWOCR. Pellarin, D. J.; Baumann, N. P.; Crandall, J. L.; O'Neill, G. F.; Satterfield, R. M. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Nov. 1967. Contract AT(07-2)-1. 100p. Dep. CFSTI.

Lattice physics experiments were performed in the Process Development Pile (PDP) and the Subcritical Experiment (SE) to investigate thorium loadings for the Heavy Water Organic Cooled Reactor (HWOCR). The test fuel assemblies consisted of 85-rod clusters of THUD fuel, aluminum-clad rods of 0.234-inch UO_2–ThO_2 pellets with a Th/^{235}U ratio of 49.03, and of coaxial U–Th metal tubes with approximately the same Th/^{235}U ratio. These fuel assemblies were arranged into regular lattices at pitches of 9.0, 9.5, 10.5, and 12.12 inches in D_2O and tested with D_2O, air and Dowtherm A occupying the fuel coolant channels. Measurements included critical and exponential substitution buckling determinations and a variety of foil activations aimed at determining the subcadmium neutron distributions, the neutron temperatures, the cadmium ratios for ^{232}Th and ^{238}U, the ^{232}Th captures, and the ^{232}Th/^{235}U fission ratios. Most of the measurements were performed at room temperature, but some foil activations were performed with the thoria fuel and with urania fuel in Dowtherm A coolant at temperatures up to 195°C. The experimental results were compared with calculations by the HAMMER code, which performs lattice cell calculations in 84 neutron energy groups by integral transport methods. Agreement between the calculated and measured bucklings was within ±25 μB. From the detailed parameter measurements, it was estimated that the HAMMER code could calculate the neutron economy of all the systems studied within 1%. (auth)

20808 (DPST-68-83-2) USAEC–AECL COOPERATIVE PROGRAM. Monthly Progress Report, February 1968. Hilborn, H. S. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Feb. 20, 1968. Contract AT(07-2)-1. 10p. Dep. CFSTI.

The fuel spacing plates and housing assemblies to be used in reactor physics measurements for the heavy water moderated power reactor development program are described. (H.D.R.)

20809 (EUR-3662) ETUDE DES PROBLEMES DE SELECTION ET DE FORMATION DU PERSONNEL D'EXPLOITATION DES CENTRALES NUCLEAIRES DES PAYS DES COMMUNAUTES EUROPEENNES. (Study of Problems of Selecting and Training Personnel to Operate the Community's Nuclear Power Plants). (Societe Europeenne d'Assistance et de Conseil, Neuilly-sur-Seine (France)). Dec. 1967. Contract 026-66-2 ECIF. 544p. (In French). Dep.

The present situation regarding personnel in the various EURATOM plants and the training methods and facilities employed are described. A comparative study of jobs and of the selection and training processes is also presented. The trend of requirements over the next ten years is outlined, and suggestions concerning the creation of a schooling power plant, the preparation of programmed courses, and the development of an objective selection system, are presented. (auth)

20810 (EUR-3898) LIST OF THEORETICAL AND EXPERIMENTAL WORK WHICH CAN BE CARRIED OUT BY THE COMMISSION IN CONNECTION WITH HEAVY WATER REACTOR DEVELOPMENT. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Mar. 1968. 46p. Dep.

The experience acquired within EURATOM in the framework of the studies carried out for the ORGEL Project since 1960 is described. This experience covers the theoretical and the experimental fields, in a broad spectrum going from work on materials to reactor physics. They are supported by a range of facilities, described in the second part of the document, among which the two most important are the ECO critical reactor and the ESSOR reactor for testing sub-assemblies along with its two hot laboratories. (auth)

20811 (EURAEC-1964) STABILITY TESTS ON BOILING WATER REACTORS. Quarterly Report No. 11, July 1–September 30, 1967. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany)). 49p. (EUR-3773). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Tests were performed during flow oscillations in the four rod clusters geometry test section. Altogether 16 transfer functions "water inlet velocity–local void fraction" were measured, different test parameters being varied: heat flux, subcooling and mean mass flow rate. These parameters were chosen in such a way that it will be possible to compare the obtained transfer functions with the heat flux oscillation measurements. During the recent tests, local void fraction measurements were made at four axial positions along the boiling length to obtain sufficient signals for void fraction integration. To study undesirable influences on measured transfer functions void fraction oscillations in conjunction with constant heat flux and constant water inlet velocity were analyzed as a function of frequency. Two computer codes, FREGA and IVS-MAUS, used for the test evaluations were combined to the new program FREGAUS for simplification. (auth)

20812 (FEI-68) ISSLEDOVANIE FIZICHESKIKH KHARAKTERISTIK VODO-VODYANOGO REAKTORA S OBGORAYUSHCHIMI POGLOTITELYAMI. (Investigation of the Physical Characteristics of a Water-Moderated Water-Cooled Reactor With Burnable Poison). Inyutin, E. I.; Karchava, G. A.; Matveenko, V. I.; Morozov, I. G.; Orekhov, Yu. I.; Plaksin, E. A.; Sergeev, Yu. A.; Sidorov, G. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1967. 16p. (In Russian). Dep.

Results of theoretical and experimental investigations of the reactor designed to power a small generating plant are reported. The measurements were done at 20–230°C. The setup described consisted of fuel assemblies with stainless steel sheaths and highly enriched uranium. The design permitted the introduction of various burnable poisons such as boron steel sheet or Gd and Cd-filled rods. A study was made of the compensating capacity of the burnable poison rods as a function of their number and distribution in the core, fuel distribution, and the temperature effect of assemblies containing blocked (Gd and Cd) and unblocked (B) poison. (JPRS)

20813 (GEAP-5534(Pt.1)) CONTROL ROD OSCILLATOR TESTS, GARIGLIANO NUCLEAR REACTOR. Lahey, R. T. Jr.; Howard, C. L.; Calcagno, M. J.; Vincenti, E.; Santarossa, G. L. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Aug. 1967. Contract AT(04-3)-189. 306p. (EURAEC-1941). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

The results of an extensive series of rod oscillator tests performed on the Garigliano boiling water reactor are presented. Both the numerical results and the individual plots obtained from digital reduction of the data are documented in detail. Details of the test procedures and equipment are also included. Appendixes contain descriptions of the method of data reduction, the anticipated errors, and FORTRAN listings used in the data reduction. (H.D.R.)

20814 (HPR–79) CALIBRATION TECHNIQUES AND DATA HANDLING EQUIPMENT FOR INSTRUMENTED FUEL ASSEMBLIES IN HBWR. Aarset, B. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Dec. 1967. 63p. Dep.

In HBWR measurements of coolant flow and temperatures in instrumented fuel channels are used to determine assembly power for the purpose of calibrating the power indicators, gamma thermometers and beta current neutron detectors, which are essential for the study of various fuel assembly parameters related to assembly power, such as channel hydraulics, burn-up, burn-out, and fuel temperatures. Various methods are used for the power measurement depending on the coolant condition in the channel: no boiling, various degrees of boiling as controlled through subcooling, or high outlet steam qualities with no subcooling. Accuracies in the order of ±3–5% are achieved. Careful out-of-pile and in-pile calibration and checking of various instruments are performed prior to the power measurements. To handle the signals from about 40 instrumented fuel assemblies installed in the reactor, extensive rationalizing of the data handling system has been arranged. The handling system comprises transducer electronics, recorders, analogue computer, data logger with electronic multiplexer and A/D converter, magnetic tape recorder, and a digital computer. All in-core signals and various parts of the data processing equipment are terminated on a special terminating rack. (auth)

20815 (HPR–82) IN-PILE AND OUT-OF-PILE HYDRODYNAMIC STUDIES ON NATURAL CIRCULATION BOILING WATER CHANNELS. Bjoerlo, T. J.; Eurola, T.; Grumbach, R.; Lunde, J. E.; Post, J. H.; Romslo, K.; Tosi, V.; Walger, H. G. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Dec. 1967. 140p. Dep.

The hydrodynamic performance of natural circulation boiling water channels has been investigated both in the Halden Boiling Water Reactor and in an out-of-pile loop. In-pile dynamic coupling experiments were also performed. Tubular fuel assemblies in natural circulation were used. The assemblies were equipped with instruments permitting dynamic measurements of channel power, temperature, coolant velocity and exit void fraction. Sinusoidal perturbations in channel heat flux were applied. The experimental results include steady state hydraulic characteristics, approaches to flow instabilities as determined by noise analysis, and transfer functions from heat flux to coolant inlet velocity and to exit void fraction. The experiments were conducted at system temperatures ranging from 200 to 230°C (15–28 ata), channel powers 20 to 200 kW, and subcooled powers 0 to 35 kW. Significant differences between inpile and out-of-pile results have been found. In the dynamic coupling experiments, the inlet flow in one assembly was perturbed. The transfer functions relating the perturbed flow to the flow in the neighbouring channel and to the neutron flux and the vessel pressure were determined. Noise technique was used to determine the auto-power density spectra of these variables. The results obtained from the coupling experiments indicate that no coupling exists between two adjacent channels. The hydrodynamic characteristics measured in the loop experiments have been compared to predictions applying several theoretical models. Included are some of the calculations related to the Halden loop experiments. A complete presentation of the comparative studies is given in a separate report. (auth)

20816 (HPR–94) OPERATIONAL EXPERIENCE WITH THE HBWR ON ITS SECOND FUEL CHARGE. Jamne, E. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Dec. 1967. 96p. Dep.

HALDEN BOILING REACTOR — operations during 1964 to 1966; power production review during 1964 to 1966; temperature records during 1964 to 1966; shutdown schedule for, description of fuel handling

HEAT TRANSFER SYSTEMS — operation efficiency of Halden Boiling Reactor, description of

REACTOR FUEL ELEMENTS — thermal characteristics of Halden Boiling Reactor at 20 MW; shielding plug caps for Halden Boiling Reactor, description of; assembly of, description of Halden Boiling Reactor

PRESSURE VESSELS — fracture transition temperature of Halden Boiling Reactor, testing analysis for brittle SEALS AND GLANDS — performance of Halden Boiling Reactor pressure vessel, description of

REACTOR CONTROL ELEMENTS — description of Halden Boiling Reactor

REACTOR CONTROL SYSTEMS — circuit diagrams of Halden Boiling Reactor

RADIATION MONITORING — measurement of Halden Boiling Reactor personnel doses

REACTOR CONTAINMENT SYSTEMS — description of Halden (H.D.R.)

20817 (CONF-660553–4) LES PROPRIETES DU REFRIGERANT. (Coolant Properties). Hannaert, H.; Cardozo, R. Lopes (European Atomic Energy Community, Ispra (Italy). [Joint Nuclear Research Center]). [1966]. 24p. (In French). Dep.

From Panel on Use of Organic Liquids as Reactor Coolants and Moderators, Vienna, Austria.

The properties of an isomeric mixture of terphenyls of the composition ortho 25 wt.%; meta 71 wt.%; para 3–4 wt.%; and diphenyl <1 wt.%, were investigated. This mixture is a by-product of the process for obtaining diphenyl by pyrolysis of benzene. The variations of isomeric content depend mainly on the substances used as cracking catalysts. A number of individual measurements (e.g., of electrical conductivity, surface tension, heat of fusion) were carried out. Measurements were also made using coolant degraded in-pile. These measurements were made taking into account not only the total content of heavy elements but also their composition, based on the distribution of molecular weights. The main stress was laid on viscosity measurements. The satisfactory chemical behavior of this coolant was demonstrated by studying its compatibility with the main materials with which it comes into contact, such as sintered aluminum powder, steel, and uranium carbide. This made it possible to lay down certain tolerances in regard to mineral impurities. A hydrocarbon mixture with a high content of phenanthrene derivatives, obtained by distilling the power-forming residue, was considered as starting fluid. Physical and chemical measurements were also carried out on both the virgin fluid and the degraded fluid. (auth)

20818 (NP–17271) POWER SUPPLY IN SWEDEN IN THE 1970's, 1967 Study by CDL. Norrby, J.; Sterne, B.; Larsson, Y.; Nordstroem, B.; Holmin, N. (Centre de Recherches de la Soierie et des Industries Textiles, Lyon (France)). Dec. 1967. 89p. (In Swedish). Dep.

Includes 10p. Summary in English.

The Central Operating Management (CDL) study of electric power production in Sweden in the 1970's is presented. The study indicates that in 1980 hydropower will still be the prime power source in Sweden — 60 TWh of a total production of 127 TWh. During the ten year period 1970 to 1980 an increase in nuclear power production from 1 to 39 TWh is expected. An estimation of the situation in 1985 predicts that nuclear power definitely will become the prime power source. At a total production of 180 TWh, half is estimated to be nuclear power, ⅓ hydro power and ⅙ oilbased condensing and back pressure power. (Sweden)

20819 (ORNL-TM-2098) TUBE VIBRATION IN MSRE PRIMARY HEAT EXCHANGER. Kedl, R. J.; McGlothlan, C. K. (Oak Ridge National Lab., Tenn.). Jan. 3, 1968. Contract W-7405-eng-26. 43p. Dep. CFSTI.

The primary heat exchanger for the Molten-Salt Reactor Experiment was completed in 1963. Preoperational tests with water revealed excessive tube vibrations and high fluid pressure drop on the shell side of the exchanger. Modifications were made to correct these deficiencies. From January 1965 through November 1967 the heat exchanger has operated for about 14,000 hours in molten salt without indications of leakage or change in performance. (auth)

20820 (RT/ING–(67)16) AN ANALOG ITERATIVE MODEL FOR THE CALCULATION OF COOLANT DENSITY IN PRESSURE-TUBE NUCLEAR BOILER CHANNELS. Petrarca, S. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 30p. (CONF-670835–1). Dep.

From 5th International Congress of AICA, Lausanne, Switzerland.

An analog iterative model for the calculation of the coolant density along the channel of a pressure-tube water boiling nuclear reactor is presented. A generator for the two-variable function $F(x,y) = x^y$, realized by standard elements of a PACE 231-R computer for the calculation of an empirical correlation between the quality and the density of the two-phase mixture, is described. The adaption of a slow analog computer (for example PACE 231-R) to fast iterative computation is described. Calculations made by the model showed its accuracy to be excellent in large ranges of flow rate, pressure and heat flux. (auth)

20821 (TID-24255) GARIGLIANO NUCLEAR POWER PLANT. Operation Report for the 3rd Quarter of 1967. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Sept. 30, 1967. 18p. Dep.

The operation and activity of the Garigliano station from July 1 to September 30, 1967, are reported. The reactor was shut down during the entire month of July, and the main plant maintenance performed during this period is described. Operating statistics, core performance evaluation, plant chemistry, and health physics activities are summarized. (H.D.R.)

20822 (TID-24283) NUCLEAR POWER PLANT, GUNDREMMINGEN (KRB), ANNUAL REPORT 1966. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). 65p. Dep. CFSTI.

GUNDREMMINGEN POWER REACTOR — testing of systems of, description of pre-startup
REACTIVITY — measurement of Gundremmingen Power Reactor
LICENSING AND REGULATION — testing of Gundremmingen Power Reactor systems for, description of
GUNDREMMINGEN POWER REACTOR — construction of, economics of
CRITICALITY STUDIES — power testing of Gundremmingen Power Reactor, analysis of zero and non-zero (D.L.C.)

20823 (UNC-5200) PERFORMANCE EVALUATION OF HEAT EXCHANGERS FOR SODIUM-COOLED REACTORS. Quarterly Technical Progress Report, October 1-December 31, 1967. Israel, S. L.; Nolan, D. J.; Malmborg, F. B. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Jan. 20, 1968. Contract AT(11-1)-1452. 41p. Dep. CFSTI.

The evaluation of the thermal-hydraulic and structural performance of heat exchangers for sodium-cooled reactor plants is discussed. The evaluation will be based on the results of tests of model heat exchangers [approximately 30 MW(t)] in the Sodium Components Test Installation (SCTI). An intermediate heat exchanger designed and manufactured by ALCO Products, Inc., (ALCO) and a steam generator designed by ALCO and manufactured by Baldwin-Lima-Hamilton Corporation (BLH) are the first units to be tested. A Babcock & Wilcox (B&W) steam generator is to be tested next. Several sets of test data were utilized to confirm that the temperature distributions in the lower tubesheet area of the ALCO/BLH steam generator were not axially symmetric, as had been assumed by ALCO in calculating stresses in this structurally critical region. The presence of the sodium outlet nozzle and sodium bypass flow through a drain slot in the shell liner were investigated as possible causes for this condition. A review of the entire instrumentation system was initiated to assure that all necessary information was available for proper reduction and interpretation of experimental data. As a result of this review, some changes in instrumentation, especially for strain gages, were recommended. The latest revision to the Steady State Performance Test Procedures (SCTI-C-1002) was reviewed. Intermediate heat exchanger vibration tests were witnessed. Explanations were sought for vibration peaks at certain frequencies and flow rates. Tube vibration and entrained gas are possible causes for the vibrations, but further tests were suggested to substantiate these hypotheses. (auth)

20824 (WAPD-MRP-123) PRESSURIZED WATER REACTOR (PWR) PROJECT. Technical Progress Report, October 21, 1967-January 26, 1968. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Contract AT(11-1)-Gen-14. 52p. Dep. CFSTI.

SHIPPINGPORT PRESSURIZED-WATER REACTOR — operation during October 1967 to January 1968
SHIPPINGPORT PRESSURIZED-WATER REACTOR — performance during October 1967 to January 1968
SHIPPINGPORT PRESSURIZED-WATER REACTOR — cooling system of, effects of pH and power level on ammonia addition rates in
REACTOR FUEL ELEMENTS — fabrication of Shippingport Pressurized-Water Reactor Core 2 Seed 2
NEUTRONS, THERMAL — flux distribution measurements in Shippingport Pressurized-Water Reactor Core 2
NEUTRONS, EPITHERMAL — flux distribution measurements in Shippingport Pressurized-Water Reactor Core 2
REACTOR CONTROL ELEMENTS — effects of xenon burnup on position of, in Shippingport Pressurized-Water Reactor Core 2 Seed 1
REACTOR FUEL ELEMENTS — burnup analysis of Shippingport Pressurized-Water Reactor Core 2 Seed 2
HEAT TRANSFER SYSTEMS — effects of pH and power level on ammonia addition rates in Shippingport Pressurized Water Reactor
SHIPPINGPORT PRESSURIZED WATER REACTOR — fuel elements for Core 2 Seed 2 of, fabrication of
SHIPPINGPORT PRESSURIZED WATER REACTOR — neutron flux distribution measurements in Core 2 of, epithermal and thermal
SHIPPINGPORT PRESSURIZED WATER REACTOR — control elements in Core 2 Seed 1 of, effects of xenon burnup on position of
SHIPPINGPORT PRESSURIZED WATER REACTOR — fuel elements for Core 2 Seed 2 of, burnup analysis of
SHIPPINGPORT PRESSURIZED WATER REACTOR — criticality of, Core 2 Seed 1 of, effects of xenon burnup and control rod position on (D.C.C.)

20825 (WCAP-3690-4) DESCRIPTION AND EVALUATION OF THE BORON CONCENTRATION METER UTILIZED AT THE SENA (FRANCO-BELGE) REACTOR PLANT. Fletcher, W. D. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Jan. 1968. Contract AT(30-1)-3690. 19p. (EURAEC-1972). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

A comprehensive review of the operational characteristics of the SENA Boron Meter was made and general applicability to nuclear power plants assessed. The meter is commercially available, but certain techniques were developed by SENA to adapt the meter for analysis of boron in a sample stream from the reactor coolant system. The method is colorimetric, utilizing the specific reaction of phthalein violet with aqueous boric acid solutions. (auth)

20826 (ZFK-RN-31, pp 69-76) VODOOCHISTKA I VODOPODGOTOVKA NA YADERNYKH REAKTORAKH. SOOBSHCHENIE III. (Purification and Treatment of Water for Nuclear Reactors. Report III). Chernorotov, E. S.; Potekhin, N. V.; Novikov, P. D. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). (In Russian).

A method for improved efficiency of mixed-layer ion exchangers for water purification in the primary circuits of research and power reactors is presented. The method consists of using prefilter units or h-shaped layers of cation exchangers. Results of using the system in the RFT research reactor and with the nuclear-powered ice-breaker "Lenin" are presented. (auth)

20827 (ZFK-RN-31, pp 98-109) PROBLEMY OCHISTKI TYAZHELOI VODY IONOOBMENNYM METODOM. (Problems of Purification of Heavy Water by Ion Exchange). Ling, Fon-Lien; Tia, Shu-yun; T'ung, T'ien-cheng (Chinese Academy of Sciences, Peking. Inst. of Atomic Energy). (In Russian).

The indirect method for the detection of deuteron content of the exchange product in cooling circuit purification of heavy water reactors is described. The parameters affecting the deuteron formation in the ion exchanger are presented. (auth)

20828 STABILITY OF A NUCLEAR REACTOR I. E. OF AN OBJECT HAVING A TIME DELAY. Gorjacenko, V. D.; Trunin, J. F. Jad. Energ., 14: 89-92(Mar. 1968). (In Czech).

Calculations are given on the stability of nuclear power installation consisting of a heterogeneous reactor and a heat-exchanger. (R.V.J.)

20829 DESIGN OF THE ELECTRICAL SYSTEMS AND OF THE CONTROL AND INSTRUMENTATION OF A NUCLEAR POWER PLANT. Taurit, R. (Allgemeinen Elektricitaets-Gesellschaft AEG-Telefunken, Frankfurt am Main). Kerntechnik, 10: 10-20(Jan. 1968). (In German).

The problems and scope of the design of electrical power systems and of the control and instrumentation systems of a nuclear power plant are discussed referring to examples taken from the 245-MW(e) Gundremmingen KRB plant. Besides a reliable emergency power system, particular consideration must also be given to the safety circuits of important systems which must be designed so as to ensure safe operation on the one hand and high plant availability on the other. The design of the nuclear instrumentation is discussed and the control system of the plant is described, with particular reference to the self-regulating features of a dual cycle boiling water reactor plant. (auth)

20830 AGR MATERIALS. Hutcheon, J. M. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). BNX Rev., No. 2, 17-23(Nov. 1967).

The evaluation of AGR materials was based on a reactor life of 30 yr at 85% load factor. The properties of the pressure vessel concrete and prestressing tendons are discussed and the mold steel of the associated liner was checked for liability to brittle fracture and for fatigue life. Studies of materials for the insulation and heat exchanger tubing are continuing. Aspects of the neutron damage to the graphite moderator include dimensional changes, creep, and effects on thermal conductivity. Moderator oxidation loss and the consequent loss of strength are discussed. A description is presented of the effect of coolant additives and of methods of coolant

composition control. Representative results of property tests are included. (UK)

20831 TECHNICAL PROGRESS IN THE DESIGN AND CONSTRUCTION OF NUCLEAR PLANTS IN THE UNITED KINGDOM. Smith, D. R. (Nuclear Power Group, Knutsford, Eng.). BNX Rev., No. 2, 55-63(Nov. 1967).

The improvements taking place in the thermal efficiency, coolant pressure, rating, and generation cost of gas cooled reactors are illustrated. Operation and construction experience on the Magnox stations is reviewed. The continuing development of the AGR and HTR designs is surveyed. (UK)

20832 THEORETICAL STUDIES OF THE RESPONSE OF FAST REACTORS DURING SODIUM BOILING ACCIDENTS. MacFarlane, D. R.; MacNeal, N.; Meneley, D. A.; Sanathanan, C. I. (Argonne National Lab., Ill.). Bull. Inform. Sci. Tech. (Paris), No. 122, 35-52(Jan. 1968). (In French).

A calculational method for the transient phenomena which can take place during coolant boiling in a reactor core is described. It is thus possible to study the weak overpower transients originating from the reactivity addition or those originating from the coolant flow shut down. The model should also permit the formulation and analysis of transient boiling experiments which should supply still missing data. The calculations apply particularly to ceramics fueled and sodium cooled fast breeder power reactors. (auth)

20833 SUPERHEAT MEASUREMENT AND STUDY OF LIQUID METAL BOILING. Grass, G.; Kottowski, H.; Spiller, J. H. (EURATOM, Ispra, Italy). Bull. Inform. Sci. Tech. (Paris), No. 122, 25-34(Jan. 1968). (In French).

In order to study the mechanism of liquid metal boiling, its maximum possible superheat has been measured. Potassium has been chosen as the working liquid. Very important superheatings—going up as far as 800°C in particular cases—have been obtained in highly purified stagnant K. In the loop, where the degree of purification is less, the observed superheatings have been much lower and remain below 130°C. The boiling mechanism showed to be a series of liquid metal ejections, expelled by the vapor bubbles. The frequency and expulsion rate depend on the original superheat and on the corresponding vapour pressure. (auth)

20834 SODIUM BOILING IN FAST NEUTRON REACTOR CORES. Semeria, R. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 122, 19-23(Jan. 1968). (In French).

A description of the physical phenomena which occur during Na boiling and flashing out of the reactor core is attempted. The characteristics of the calculation codes as well as the goals of these codes are briefly presented. The important results gained from the current studies are outlined. (auth)

20835 ELECTRICAL INSTALLATION AND INSTRUMENTATION. Smits van Waesberghe, J. P. M. Electrotechniek, 45: 257-9(June 1, 1967). (In Dutch).

Conceptual layout of power supply and instrumentation for nuclear power plants is compared to the analogue lay-out for conventional plants. Some attention is given to the control of a nuclear power plant in combination with a boiling water reactor; a simplified reactor control block diagram is explained. The network is described together with the several power supply sources. The main instrumentation systems are mentioned and a brief summary of special in core instrumentation is given. (auth)

20836 THE FIRST TEN YEARS OF ACTIVITIES OF THE ENEA. Adkins, B. (European Nuclear Energy Agency, Parigi, Italy). Energ. Nucl. (Milan), 15: No. 2, 17-21(Feb. 1968). (In Italian).

A review of actions undertaken by the European Nuclear Energy Agency over the past ten years to promote international cooperation in the development of nuclear energy for peaceful applications is presented. (auth)

20837 OUTLINES OF AN R AND D PROGRAM IN THE NUCLEAR FIELD. Villani, S. (CISE, Milan). Energ. Nucl. (Milan), 15: No. 2, 28-34(Feb. 1968).

The CIRENE Program for the development of a new nuclear reactor concept, currently in progress in Italy, is presented as an example of experience applicable—to a certain extent—to other similar R & D programs. The evolution of such program from the basic concept, through its successive stages, to the preliminary design are outlined, together with financing and budget, work organization and other relevant aspects. (auth)

20838 STEAM-WATER MIXTURE DENSITY MEASUREMENTS IN HEATED CHANNELS AT HIGH PRESSURE BY MEANS OF A QUICK-CLOSING VALVE METHOD. Colombo, A.; Hassid, A.; Premoli, A. (CISE, Milan). Energ. Nucl. (Milan), 15: No. 2, 35-44(Feb. 1968).

A technique, developed for the measurement of the average density of steam-water mixtures in power channels is described. The technique is based on the use of two simultaneously operated quick-closing valves, located at the inlet and outlet of the boiling channel respectively. This technqiue appears to be an efficient device for measuring density in the whole quality range, even under subcooled conditions as well as with or without heat addition up to 70 kG/cm^2 in steam-water mixtures, the corresponding accuracy being better than most other available techniques. Preliminary results, obtained at 30 and 50 kG/cm^2 in a tubular test element. are presented. (auth)

20839 NUCLEAR POWER ENGINEERING IN THE U.S.S.R. Ermakov, G. V. Elektr. Sta., No. 38, 36-40(Nov. 1967). (In Russian).

A review of developments in Soviet nuclear power engineering is presented. A description is given of the Beloyar nuclear power station with channel-type reactors and graphite moderators, started up in 1963. The reactor steam conditions are 90 atm., 500°C. An account is also presented of the Novovoronezh nuclear power station where the first unit was started up in 1964 and has a design output of 210 MW. The Bibibinsk thermo-electric nuclear power station is examined and several smaller stations are discussed. (UK)

20840 SPECIAL FACILITIES, PIPES, AND DUCTS OF THE ATOMIC POWER STATION. Muramatsu, Takio (Ebara Mfg. Co., Ltd., Tokyo). Haikan Gijutsu, 9: 88-94(July 1967). (In Japanese).

Differing from ordinary oil-burning power stations, the atomic power station must be designed under various limitations because of the radiation protection and also due to the handling of radioactive materials. The Tokai power station of JAPC employs a Calder Hall type reactor, CO_2 gas cooled and graphite moderated, imported from England. It differs from the water reactors in the handling of CO_2 gas and natural uranium. The handling of a gas is involved in the graphite-sleeve removal system. The radioactive-effluent disposal system is used to handle the liquids, and mixed gas and liquid is handled in the heavy-equipment decontamination system. A description is made of the systems and of the problems in designing and constructing the systems. (NSA of Japan)

20841 OVERALL STATION CONTROL AT HUNTERSTON "A" NUCLEAR POWER STATION. Proc. Inst. Elec. Eng. (London), 114: 2001-2(Dec. 1967).

The discussion of the paper by Spurgin and Carstairs read before Institution of Mechanical Engineers (London), 7th March 1967, is presented. (UK)

20842 THE USE OF PRESTRESSED CONCRETE FOR THE WATERTIGHT ENCLOSURE OF EL-4. Balensi, Pierre. Ind. At., 11: No. 11-12, 55-61(1967). (In French).

Reasons for use of prestressed concrete for the EL-4 reactor vessel are presented. Characteristic dimensions of the prestressed concrete vessel are given; placement of the prestressing tendons is discussed. Methods used for testing the vessel are outlined. Use of prestressed concrete is compared with use of metal for reactor vessels. (M.L.S.)

20843 COMING AGE OF NUCLEAR ENERGY. Weinberg, Alvin M. (Oak Ridge National Lab., Tenn.). Atoomenergie Haar Toepass., 10: 7-12(Jan. 1968).

During the twenty five years of its development, nuclear energy has become fully competitive with energy from fossil fuel sources. The potential for future development of large agro-industrial complexes utilizing nuclear reactors is examined. The development of the advanced breeder is proposed as the next major task for assurance of future supplies of cheap, virtually limitless, energy. 4 references. (H.D.R.)

20844 METHODS AND RESULTS OF THE CALCULATIONS OF THE GRAPHITE-MODERATED HIGH-TEMPERATURE REACTOR AVR. Massimo, L.; Rott, H. P.; Schroeder, E. (Brown Boveri/Krupp Reaktorbau GmbH, Mannheim, Ger.). Atomkernenergie, 13: 77-9(Mar.-Apr. 1968). (In German).

The geometry of the pebble-bed reactor AVR and the loading of its first critical core is described. The methods and the computer-codes of the diffusion-calculations are dealt with and the results of these calculations are discussed and compared with the experimental results. (auth)

20845 SPECIAL PROBLEMS IN THE DYNAMICS OF GAS COOLED AND GRAPHITE MODERATED HIGH TEMPERATURE REACTORS. Friedrich, K.; Infuehr, E.; Massimo, L. (Brown Bover!/Krupp Reaktorbau GmbH, Mannheim, Ger.). Atomkern-energie, 13: 80-3(Mar.-Apr. 1968). (In German).

Described are two simple methods to calculate the ^{135}Xe and ^{149}Sm concentrations for zero-dimensional dynamic calculations, with better accuracy than with the conventional procedure. The feedback of these concentrations on reactivity is investigated. Reported are the behavior at partial power of the planned THTR reactor and the calculation of the effective delayed neutron fraction. (auth)

20846 PARAMETRIC STUDY OF THE DYNAMIC BEHAVIOR AND STABILITY OF A STEAM-COOLED FAST REACTOR WITH AN INTEGRATED COOLING CYCLE. Erbacher, F.; Frisch, W.; Huebschmann, W.; Malang, S.; Ritz, L.; Wolte, G. (Kernforschungszentrum, Karlsruhe, Ger.). Atomkernenergie, 13: 85-94(Mar.-Apr. 1968). (In German).

In a steam-cooled fast breeder reactor it is possible in principle to produce inherent stability and safety from accidents by the feedback of the cooling cycle on the core. The effects of various parameters on stability and safety are determined for these disturbances: reactivity disturbance, blower failure, load changes, various pipe ruptures, and inadvertent fast unflooding. This results in trends and limits that should be observed in the design of the components and the arrangement of the cooling cycle. It is shown that in particular a cooling cycle integrated in a common pressure vessel produces easily inherent stability and safety of a steam-cooled fast reactor. (auth)

20847 STEAM-GENERATING HEAVY-WATER REACTOR. Engineering, 225: 359-61(Mar. 1, 1968).

A brief description is given of the 100 MW SGHWR at Winfrith (U.K.) which reached full power in January 1968. The achievement of the construction schedule in spite of Hg contamination of the calandria is noted. The suitability of the design for commercial power station is discussed. (UK)

20848 NUCLEAR POWER STATION IN CALIFORNIA: 450 MW PRESSURIZED WATER REACTOR. Engineering, 225: 382-4(Mar. 1, 1968).

A description is given of the San Onofre nuclear generating station which went into commercial operation in January 1968. It is the first large power reactor to employ rod-cluster-control in place of cruciform control rods. The start-up programme is summarized. (UK)

20849 ADVANCES IN NUCLEAR SCIENCE AND TECHNOLOGY. VOLUME 4. Greebler Paul; Henley, Ernest J. (eds.). New York, Academic Press Inc., 1968. 405p. $18.50.

Included are 7 chapters covering various aspects of the development of advanced reactor concepts for electrical power generation. Separate abstracts were prepared for 6 of the chapters. The remaining chapter covers the application of modern perturbation theory in reactor physics calculations. (H.D.R.)

For abstracts of individual chapters see: 19056, 20850–20853, and 20946.

20850 GAS-COOLED REACTOR TECHNOLOGY. Stewart, H. B.; Rickard, C. L.; Melese, G. B. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Advan. Nucl. Sci. Technol., 4: 1-66(1968).

The history of the development of gas-cooled reactors is presented to illustrate the characteristics of the various types of gas-cooled reactors and to indicate the development trends and potential of this class of reactors. Design characteristics of typical reactors are summarized, and the development of coolant gases, moderators, fuel elements, plant equipment, and fuel cycles is examined in detail. 64 references. (H.D.R.)

20851 SAFETY AND ECONOMIC CHARACTERISTICS OF A 1000-MWe FAST SODIUM-COOLED REACTOR DESIGN. Cohen, K. P.; O'Neill, G. L. (General Electric Co., Sunnyvale, Calif.). Advan. Nucl. Sci. Technol., 4: 67-107(1968).

The safety criteria and operating limits for fuel, cladding, and coolant are examined for large, fast nuclear reactors by describing a design approach in the light of present technology. A preliminary reference reactor core, coolant system, and containment design are presented, and hazards analyses are performed to predict the dynamic response of the reactor and plant to credible plant accidents. The hazards analyses are extended to include hypothetical accidents, and a containment concept is designed and analyzed to prove its adequacy for the hypothetical accident. The plant economics are estimated, with emphasis on the effect of the safety assumptions on the fuel cycle costs. The possible effect on fuel cycle costs of physics data uncertainties and changes in fuel performance limits are also determined. (H.D.R.)

20852 THE DOPPLER EFFECT IN FAST REACTORS. Nicholson, R. B. (Univ. of Wisconsin, Madison); Fischer, E. A. Advan. Nucl. Sci. Technol., 4: 109-95(1968).

The theory of the Doppler effect is examined from the standpoint of its importance in the design and safety evaluation of large fast breeder reactors. The theoretical basis for the calculation of Doppler temperature coefficients of reactivity is presented, and the various parameters involved in their calculation are examined. Some representative numerical results on Doppler coefficients, effective cross sections, and auxiliary functions used in the calculation of Doppler coefficients are included. 78 references. (H.D.R.)

20853 FAST REACTOR MELTDOWN ACCIDENTS USING BETHE–TAIT ANALYSIS. Meyer, R. A.; Wolfe, B. (General Electric Co., Sunnyvale, Calif.). Advan. Nucl. Sci. Technol., 4: 197-250(1968).

The energy release from a meltdown accident is examined with reference to a 1000 MW(e) fast ceramic-fueled power reactor. The intent is to show the effect of the basic parameters on the energy release. Various reactivity insertion rates or reactivity steps are assumed, and the energy release as a function of the reactor parameters is investigated to assess the importance of these parameters and the sensitivity of the results to the assumptions that must be made. Specific parameters considered are Doppler coefficient, neutron lifetime, pressure-energy relationship for the fuel, core composition, power flattening, specific heat of the fuel, core shape, and initial conditions at the start of the reactivity input. It is shown that, if the Doppler coefficient is made large enough, the energy release from a large power reactor excursion can be made of the same order of magnitude as that for which containment has already been engineered in the present generation of experimental reactors. (auth)

20854 NUCLEAR SAFETY. Volume 9, Number 2. Cottrell, Wm. B.; Jordan, W. H.; Blakely, J. P.; Savolainen, A. W. (eds.). Contract W-7405-eng-26. One of the Four Quarterly Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Lab., Mar.-Apr. 1968. 95p. GPO $0.60.

Included are 15 reviews covering significant developments in the analysis and control of hazards associated with nuclear reactors, operations involving fissionable materials, and nuclear fission products. Separate abstracts were prepared for each of the 15 papers. (H.D.R.)

For abstracts of individual papers see: 19221, 19305, 19348, 19470, 20855–20864, and 20926.

20855 EFFECTS OF CONTAINMENT-SYSTEM SIZE ON FISSION-PRODUCT BEHAVIOR. Watson, G. M.; Perez, R. B.; Fontana, M. H. Nucl. Safety, 9: 128-37(Mar.-Apr. 1968).

Simple mathematical models are postulated to assess the effect of containment-vessel size on rate of deposition of radioiodine from gas mixtures both with and without condensable steam. For systems without steam it is assumed that the active species is molecular iodine, that complete mixing occurs in the gas phase, and that the rate-limiting process is diffusion through a stagnant boundary layer of gas presumed to envelop all surfaces. Mathematical expressions in terms of mass-transfer coefficients and surface-to-volume ratios of containers and surface characterization parameters are developed for cases with and without desorption from partially covered surfaces. In the presence of condensing steam, there is bulk flow of steam toward the walls. In such cases it is assumed that the iodine flux may be approximated by the bulk-flow component alone. Furthermore, it is assumed that the solubility of iodine in steam condensate is high enough to permit the iodine and the steam to condense together with the same composition as the gas phase. Mathematical relations are derived for the concentration of iodine as a function of time in terms of the surface-to-volume ratios, condensing steam fluxes, and steam concentrations. Mass-transfer coefficients, in the absence of steam, are estimated by using film-theory and boundary-layer analysis based on rough approximations concerning flow velocities induced within the containment by small temperature differences. Some moderately successful comparisons of the predicted and experimental results are made. 8 references. (auth)

20856 SAN ONOFRE: PWR. Ortega, O. J.; Baskin, K. P. (Southern California Edison, San Onofre). Nucl. Safety, 9: 150-7(Mar.-Apr. 1968).

The evolutionary thinking during the preparation of the technical specifications for San Onofre, Unit 1, is discussed with emphasis on some of the licensing areas where important improvements were achieved. The final document is assessed in the light of experiences obtained during initial operation of the San Onofre reactor. (auth)

20857 NINE MILE POINT: BWR. Rhode, G. K. Nucl. Safety, 9: 160-4(Mar.-Apr. 1968).

Niagara Mohawk experience in developing technical specifications for the 500-Mw(e) Nine Mile Point BWR is summarized.

Current questions on interpretations of the guidelines for developing technical specifications and advantages of the new format are discussed. (auth)

20858 VIENNA SYMPOSIUM ON CONTAINMENT AND SITING OF NUCLEAR POWER PLANTS. Gifford, F. A. Nucl. Safety, 9: 103-6(Mar.-Apr. 1968).

The third in a series of International Atomic Energy Agency symposia on reactor siting was held in Vienna in the spring of 1967. Four principal topics were considered: national practices in reactor siting, reactor siting considerations, containment, and release and transport of pollutants. (auth)

20859 NUCLEAR REACTOR SAFETY REVIEW PROCEDURES IN THE DEPARTMENT OF DEFENSE. De La Paz, A. (Fast Burst Reactor Div., White Sands Missile Range, N. Mex.). Nucl. Safety, 9: 106-11(Mar.-Apr. 1968).

The procedures followed by the Department of Defense to ensure the health and safety of the public in connection with the operation of nuclear reactors built and operated under Sec. 91b of the Atomic Energy Act of 1954, which do not require an AEC license, are discussed in terms of a regulatory review and a compliance (inspection) function. The differences between the procedures followed by the three services are noted, and the overall DOD requirements are reviewed in terms of the procedures applicable to nuclear reactors licensed by the AEC. (Naval nuclear propulsion reactors are not considered because they are covered by separate agreements.) The applicable agreements between DOD and the AEC regarding the coordination of the review procedures applicable to Sec. 91b reactors are discussed. The procedures followed by the three services in the training and certification of nuclear reactor operators are also presented. These procedures are discussed in terms of the mission and organization applicable to the specific reactor facilities involved. (auth)

20860 DYNAMICS OF COUPLED-CORE REACTORS. Raju, S. G. V. S. (Oak Ridge National Lab., Tenn.); Stone, R. S. Nucl. Safety, 9: 125-7(Mar.-Apr. 1968).

Nuclear reactors with weak coupling between isolated segments of their cores differ from "point" reactors in their kinetic behavior and should be studied as spatially dependent systems. A number of investigators have developed space- and time-dependent models for the analysis of coupled-core reactors and have found such reactors to be inherently less stable than single-core reactors. On the other hand, the extended system tends to be more sluggish than the point reactor, and therefore safety analyses based on the latter model may be overconservative for the coupled-core system. Because of the stability problem, additional attention should be directed toward control of space-dependent reactors. 21 references. (auth)

20861 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Savolainen, A. W.; Whetsel, H. B. Nucl. Safety, 9: 165-74(Mar.-Apr. 1968).

Topics on various aspects of reactor safety are summarised according to the following broad areas: Fast Reactor Safety including fast reactor meltdown studies, coolant dynamics, material behavior and energy transfer, safety experimentation for fast reactor development, radioactivity and contamination control, core dynamics, characterization of energy and aerosols generated from sodium pool fires, accident analysis and safety evaluations, and fission product release studies; Gas-Cooled Reactor Safety including fission product behavior during steam-graphite reaction, fission product behavior in in-pile radiations of high temperature gas cooled reactor fuels, large scale steam-graphite tests, ORR capsule tests on fission products at high temperature, and behavior of gasborne fission products at high temperature; Effluent Control—Environmental Studies including soil moisture flow, laboratory and analytical studies of shipping casks, geohydrologic and gas-injection studies at NRTS, and model river systems studies; Effluent Control—Waste Treatment and Disposal Program including dispersion of radioactive aerosols and gases in the atmosphere, removal of organic iodides for reactor containment atmospheres, and development of analytical model to predict travel of radioactive gases discharged to the ground; General Safety Studies including Nuclear Safety Information Center activities, heavy section steel technology program, computer handling of reactor data—safety (CHORD-S), and RDT standards. 52 references including 5 tentative RDT standards. (M.L.S.)

20862 AEC ADMINISTRATIVE ACTIVITIES. Blakely, J. P. Nucl. Safety, 9: 174-5(Mar.-Apr. 1968).

The Advisory Committee on Reactor Safeguards (ACRS) submitted a report on the Westinghouse ice containment concept, additional comments were received regarding the Commission's proposed design criteria, and a new member was appointed to the atomic safety and licensing boards (AS&LB) panel. 5 references. (auth)

20863 ACTION ON REACTOR AND OTHER PROJECTS UNDERGOING REGULATORY REVIEW OR CONSIDERATION. Blakely, J. P. Nucl. Safety, 9: 176-87(Mar.-Apr. 1968).

AEC action on the following projects is summarised: Bolsa Island, Units 1 and 2 (Docket 50-307 and 50-308), Burlington, Units 1 and 2 (Docket 50-272 and 50-311), Crystal River, Units 3 and 4 (Docket 50-302 and 50-303), Dresden 1 (Docket 50-10), Indian Point, Unit 1 (Docket 50-3), LaCrosse (Docket 115-5), Midwest Fuel Recovery Plant (Docket 50-268), Nine Mile Point (Docket 50-220), Oconee, Units 1, 2, and 3 (Docket 50-269, 50-270, and 50-287), Oyster Creek (Docket 50-219), Pathfinder (Docket 50-130), Peach Bottom, Units 1, 2, and 3 (Dockets 50-171, 50-277, and 50-278), Rancho Seco (Docket 50-312), Russellville (Docket 50-313), Surry, Units 1 and 2 (Dockets 50-280 and 50-281), and VESR (Docket 50-183). 31 references. (M.L.S.)

20864 CHANGES IN LICENSING REGULATIONS. Blakely, J. P. Nucl. Safety, 9: 187-90(Mar.-Apr. 1968).

Proposed changes in licensing regulations are tabulated. Changes to 10 CFR Parts 2, 50, 115, 20, 30, and 150 are discussed briefly. (M.L.S.)

20865 CLADDING OF URANIUM RODS WITH A METALLIC DEPOSIT. Baque, P.; Darras, R.; Koch, P. (to Commissariat a l'Energie Atomique). Canadian Patent 777,101. Jan. 30, 1968. Priority date Aug. 9, 1963, France.

After a complex cleaning process including a rinse in absolute alcohol, a thin foil of the cladding metal is applied immediately. A temperature of 350 to 400°C is maintained in vacuo until degassing is complete. Then the temperature is raised to 650° to 800°C in an inert atmosphere or in a vacuum to produce diffusion of the cladding metal in the uranium rod to a predetermined depth. Approximately 100 hours are required. Zr, Al, Cu, Nb and Ni may be used as cladding. The result is a coating without cracks or fissures on a rod intended for fuel in a gas-cooled reactor. (F.S.A.)

20866 ASSEMBLY OF FUEL ELEMENTS FOR NUCLEAR REACTORS. Charrault, J. C.; Orlowski, S. (to Communaute Europeenne de l'Energie Atomique-EURATOM). Canadian Patent 775,672. Jan. 9, 1968. Priority date Oct. 3, 1963, Belgium.

The calandria tubes in a heavy water moderator contain four or more finned fuel rods each within its own pressure tube through which an organic coolant circulates. An insulating gas such as nitrogen fills the space between the slender pressure tubes. In a variation, the fuel rod may be hollow with fins and cladding on both inside and outside surfaces, the center being occupied by a thin rod of fertile material. The coolant flows through the central space and also over the outside, with the finned fissile fuel tube enclosed in its own pressure tube. (F.S.A.)

20867 THERMAL NEUTRON REACTOR. Kambara, T.; Terasawa, S.; Arai, K. (to Kabushiki Kaisha Hitachi Seisakusho). Canadian Patent 774,687. Dec. 26, 1967. Priority date June 24, 1963, Japan.

In this reactor the core contains fuel but no control rods. A reflector surrounds the core. Between the core and the reflector or within the reflector is a circle of control plates about 10 to 15 cm wide. Each plate may be rotated about a vertical axis so that the neutron flux may impinge on the plates or pass between them to strike the reflector. The thickness of the plates is given as one cm. (F.S.A.)

20868 NUCLEAR REACTOR POWER REGULATING DEVICE. Costes, D.; Martin, R.; Lebey, J. (to Commissariat a l'Energie Atomique). Canadian Patent 777,284. Jan. 30, 1968. Priority date Oct. 13, 1964, France.

Chains made of neutron-absorbing material such as boron steel are stored loosely in canisters at the bottom of channels through the graphite in a gas cooled reactor. Attached to one end of such chains are non-neutron absorbing chains of Al or Zr alloy. The latter chains are connected to an electromagnetic drive mechanism which lift the boron steel chains into the reactor core to achieve reactivity control. (F.S.A.)

20869 CONTROL OF OVERPRESSURE IN TWO-LOOP PRESSURIZED ORGANIC-COOLED NUCLEAR REACTOR. Merli, E. (to Comitato Nazionale per l'Energia Nucleare). Canadian Patent 772,251. Nov. 21, 1967. Priority date Feb. 6, 1963, Italy.

The primary loop consists of a pressure vessel containing fuel elements, a circulating pump, an expansion vessel and a drain tank. An organic fluid circulates in this loop at high temperature and low pressure. Water circulates in a secondary loop at relatively low temperature and high pressure. A heat exchanger is

common to both loops. If failure occurs in this component, a pressure sensing device in the primary loop and a remotely controlled valve to the drain tank allow the excess pressure to be vented to the atmosphere. The pressure sensing device in the primary loop is so located that it detects excess pressure and controls the valves accordingly, thereby maintaining pressure in the primary loop at a value lower than the design pressure. The expansion vessel is connected to the inlet and outlet of the heat exchanger. (F.S.A.)

20870 METHOD OF AND APPARATUS FOR CONTROLLING START-UP OF A NUCLEAR REACTOR. (to United States Atomic Energy Commission). British Patent 1,102,824. Feb. 14, 1968. Priority date July 13, 1965, United States.

A method is provided for controlling startup of a reactor by continuously adjusting reactivity from the very lowest flux range into the power range according to a predetermined safe relationship between instantaneous flux, reactor period, and the desired final flux. The method allows operation on very short periods while the flux level is very low and automatically and continuously increases reactor period at higher flux levels into the power range to greatly reduce total startup time. (B.L.M.)

20871 DEVICE FOR CONTROLLING A CONTROL ROD IN A NUCLEAR REACTOR. Olsson, Curt Sigvard (to Aktiebolaget Atomenergi). U. S. Patent 3,347,748. Oct. 17, 1967. Priority date Mar. 25, 1965, Sweden.

The apparatus for controlling a control rod in a nuclear reactor is described. The reactor consists of a pressure vessel, a cylinder, and a slide axially displaceable in the cylinder and carrying a control rod. A double seal is provided between the slide and the cylinder. The seals divide the cylinder into a space between the first and second seals and a lower chamber. A pressure container connected to the space between seals maintains an equalizing pressure with the pressure vessel. A conduit leads from the lower chamber to the pressure container and contains pressure generating machinery. (D.C.C.)

20872 HANDLING APPARATUS FOR NUCLEAR REACTOR REFUELING FACILITY. Costes, Didier (to Commissariat a l'Energie Atomique). U. S. Patent 3,344,033. Sept. 26, 1967. Priority date Apr. 9, 1964, France.

An inclined arm and guide track are permanently mounted inside of the servicing chamber of a reactor pressure vessel and are rotatably driven about their upper end. A handling machine with a fuel element grab may be moved along the guide track or lifted upwardly out of the servicing chamber and into an operating chamber by a hoist and cable arrangement. A grab actuated brake locks the handling machine to the arm during refuelling, and a shield plug carrying cable pulleys and a short section of guide track is supported in the vertical servicing passageway and on the upper end of the arm. (auth)

20873 FAST NEUTRON REACTOR. Vendryes, Georges; Zaleski, Casimir (to Commissariat a l'Energie Atomique). U. S. Patent 3,344,032. Sept. 26, 1967. Priority date Aug. 27, 1964, France.

The description of a fast reactor is presented. The reactor is designed to operate with a substantially uniform distribution of specific power and includes: a liquid-tight tank; a reactor core located in the tank; inlet and outlet ducts for coolant flow in the tank; and a heat exchanger and pump for coolant flow. The core has the configuration of higher volumetric proportion of fissile material starting from the center and increasing to the radius. (D.C.C.)

20874 GAS-COOLED, GRAPHITE-MODERATED NUCLEAR REACTOR. Warner, Philip Cloudesley; Bennett, John Charles (to United Power Co., Ltd.). U. S. Patent 3,342,691. Sept. 19, 1967. Priority date Sept. 8, 1964, Great Britian.

The description of a gas-cooled graphite-moderated nuclear reactor is presented. The reactor consists of a pressure vessel containing heat exchangers and a gas tight enclosure to house the reactor core. Charge tubes pass from the gas tight enclosure through the pressure vessel for fuel handling. The charge tubes have apertures for circulating coolant through the pressure vessel. (D.C.C.)

20875 INTERNAL STEAM SEPARATION, PUMPING, AND FLOW PATH IN BOILING WATER REACTORS. Stern, Fred M. (to Combustion Engineering Inc.). U. S. Patent 3,342,690. Sept. 19, 1967. Filed Dec. 30, 1964.

The description of a steam separation system for a boiling reactor is presented. A centrifugal separator comprising a plurality of vanes forces the core effluent to separate and directs the steam upward and the water downward. At high quantity of effluent passage the separator rotates at high velocity, and at low quantity of effluent passage the separator rotates slowly. (D.C.C.)

20876 NUCLEAR REACTOR TRANSDUCER. Maidment, Leslie; Ledwidge, Thomas Joseph (to United Kingdom Atomic Energy Authority). U. S. Patent 3,350,271. Oct. 31, 1967. Priority date Sept. 21, 1964, Great Britain.

The description of a transducer to be used in the fuel element of a liquid sodium-cooled reactor is presented. The transducer translates a physical effect into an acoustic signal. The transducer consists of a chamber containing a liquid, a heat source for heating the liquid, and a plate with an orifice to generate an acoustic signal. (D.C.C.)

20877 PRESSURE PIPE NUCLEAR REACTOR WITH INSULATING AND PRESTRESSING ARRANGEMENT OF COAXIAL PIPE ASSEMBLY. van der Laken, Robert A. (to Reactor Centrum Nederland (Stichting)). U. S. Patent 3,350,273. Oct. 31, 1967. Priority date Mar. 2, 1964, Netherlands.

The description of a pressure pipe type reactor is presented. The reactor consists of a reactor vessel; a mass of heavy water neutron moderator material in the vessel; and a plurality of pipe assemblies extending through the moderator. The pipe assemblies contain a pressure pipe with fissile material fixed to the inner surface. A coaxial shell pipe surrounding the pressure pipe carries high pressure and high temperature fluid coolant. Thermal insulation used for the pipes is graphite. (D.C.C.)

20878 NUCLEAR POWER ECONOMICS, 1962 THROUGH 1967. REPORT OF JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETIETH CONGRESS, SECOND SESSION, FEBRUARY 1968. Washington, D. C., Joint Committee on Atomic Energy, 1968. 310p. GPO $1.00.

Presented are a series of analyses on nuclear and conventional power economics prepared for the Joint Committee on Atomic Energy and covering the years 1962 to 1967. Also included are the comments of various representatives of Government agencies and industry on the analyses and the 1962 Report to the President on Civilian Nuclear Power. (H.D.R.)

20879 LICENSING AND REGULATIONS OF NUCLEAR REACTORS. PART 2. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETIETH CONGRESS, FIRST SESSION, SEPTEMBER 12, 13, AND 14, 1967. Washington, D. C., Joint Committee on Atomic Energy, 1968. 510p. GPO $1.25.

The views of the nuclear industry and members of the general public on the licensing and regulatory program of the Atomic Energy Commission are presented. (H.D.R.)

20880 CONTROL ORGANIZATION AND METHOD FOR A NUCLEAR REACTOR. West, John M.; Bevilacqua, Frank; Snider, Albert R. (to Combustion Engineering Inc.). U. S. Patent 3,347,747. Oct. 17, 1967. Filed Dec. 15, 1960.

The description of a control system for a thermal reactor in a pressure vessel is presented. The reactor is liquid cooled by upward vertical flow. The coolant flows through a plurality of elongated tubes which rise above the core. The tubes contain spherical neutron absorption materials which are lowered by gravity and are moved upward by fluid flow. The flow is controlled by a manifold and valves to each tube. The reactor core comprises a plurality of separately removable vertical fuel assemblies retained in parallel spaced relation. Each of the fuel assemblies consists of a plurality of vertical, elongated fuel elements arrayed in a continuous perimetrically extending path. (D.C.C.)

20881 POLITICAL ECONOMY OF NUCLEAR ENERGY. Burn, D. Research Monograph No. 9. London, Institute of Economic Affairs, 1967. 152p. 21s.

A study of the development of nuclear power in the USA and UK, and an economic study of contrasting organizations in the two countries are presented. An evaluation is presented of their effectiveness under the following main headings: progress, claims and probabilities; the next generation of reactors; environmental advantages of USA; UK and USA organizations and policies contrasted; and a single design authority proposed for UK. Appendices include: nuclear power plants operable and being built in USA; reconciliation of cost estimates for Nine Mile Point and Oyster Creek; composition of British consortia. (UK)

20882 HETEROGENEOUS NUCLEAR REACTOR AND FUEL ELEMENT THEREFOR. Seltorp, Leonard J. U. S. Patent 3,350,272. Oct. 31, 1967. Priority date Oct. 28, 1960, Sweden.

The description of a spherical tank heterogeneous reactor is presented. By whirling the spherical fuel elements in the spherical tank a smooth and high burnup is achieved. The fuel elements consist of an inner sphere of liquid fuel material surrounded by an outer sphere of graphite moderator. The fuel element is arranged so that a space is provided between the fuel sphere and moderator sphere for coolant flow. (D.C.C.)

20883 NUCLEAR REACTOR WITH SPHERICAL ACTIVE ZONE. Buki, Gergely (to Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete). U. S. Patent 3,344,035. Sept. 26, 1967. Priority date May 28, 1964, Hungary.

The description of a heterogeneous nuclear reactor is presented. The reactor vessel consists of two spherical shells with a small shell enclosed in a larger shell. A pipe connects to the inner shell through the larger shell and provides coolant flow. Reactor fuel consists of small spheres located between the small reactor vessel shell and the large reactor vessel shell. Coolant flow outlets are provided in the large reactor vessel shell. (D.C.C.)

20884 FAST NUCLEAR REACTORS. Mann, John Erskine; Barker, Allan; Perks, Maurice Arthur (to United Kingdom Atomic Energy Authority). U. S. Patent 3,345,266. Oct. 3, 1967. Priority date Feb. 12, 1965, Great Britain.

A fast reactor cooled by a supercritically pressurized aqueous coolant and having a fast fuel region and an encircling radial breeder blanket region is described. Adjacent to the interface between these two regions is a coolant gap which is devoid of fertile and fissile material. The gap is comprised of a high coolant volume fraction in a Zr or Zr-base alloy structure. The use of Zr or its base alloy make a negative coolant void coefficient for the reactor more easily obtainable. (auth)

20885 LAYOUT OF HEAT EXCHANGERS AND ATTENDANT MANIFOLDS FOR A GAS-COOLED NUCLEAR REACTOR, INTERNALLY FITTED WITHIN A SINGLE PRESSURE VESSEL. (to SNAM SpA). British Patent 1,105,123. Mar. 6, 1968. Priority date Apr. 8, 1964, Italy.

The description of a pressure vessel and heat exchange, assembly for a gas-cooled reactor is presented. The heat exchanger is formed of prefabricated units and is mounted internally of the pressure vessel. Servicing the heat exchanger is accomplished through a single opening in the reinforced concrete roof of the pressure vessel. Easy access to the manifolds of the individual coil banks from outside the vessel is provided by toroidal duct sections. (D.C.C.)

20886 FUEL ASSEMBLY FOR NUCLEAR REACTOR AND A PROCESS FOR THE MANUFACTURE OF SUCH AN ASSEMBLY. Moussez, Claude Henri Charles; Rosuel, Andre Luis Roger; Du Boucheron, Gerard Marie Joseph Jean Bramaud (to Societe Nationale D'etude et de Construction de Moteurs D'aviation). British Patent 1,105,238. Mar. 6, 1968. Priority date July 23, 1965, France.

The description of a fuel assembly for a boiling reactor is presented. The fuel assembly consists of a parallelepipedal box with walls parallel to the direction of coolant flow. The fuel elements are arranged parallel to one another in a square lattice. A series of strips all having a helical twist of the same pitch are connected to form the support structure for the fuel elements. (D.C.C.)

20887 IMPROVEMENTS IN NUCLEAR REACTORS. (to Babcock and Wilcox Ltd.). British Patent 1,104,828. Feb. 28, 1968. Priority date Oct. 22, 1964, Germany.

A description of the heat transfer system for a pressurized-water reactor is presented. The heat exchange assembly is arranged in an annular space extending around the core, and the primary coolant circulating assembly is located above the core. Coolant flows upward through the core and downward over the heat exchange assembly. A shield separates the heat exchange assembly from the reactor core. After the coolant flows through the heat exchange assembly it returns to the bottom of the reactor for recirculation as primary coolant. (D.C.C.)

20888 IMPROVEMENTS IN OR RELATING TO INTEGRATED PRESSURIZED WATER REACTORS. (to Babcock and Wilcox Ltd.). British Patent 1,104,789. Feb. 28, 1968. Priority date Nov. 28, 1964, Germany.

The description of an integrated pressurized-water reactor is presented. The reactor consists of a spherical pressure vessel containing a cylindrical core and a heat exchange assembly. The heat exchange assembly encircles the cylindrical reactor core. The pressure vessel contains a pressurizer and immersed electrical heating elements and spray cooling devices. (D.C.C.)

20889 NUCLEAR REACTOR OF THE BOILING WATER TYPE. Wadmark, Lars Olof Tor (to Aktiebolaget Atomenergi). British Patent 1,103,894. Feb. 21, 1968. Priority date June 25, 1964, Sweden.

A description of the fuel elements configuration for a boiling reactor is presented. Each fuel element has a vertical flow tube surrounding it with outlets for ascending steam and water. The top of each flow tube consists of a safety device which serves as a cooling water spray from a connecting conduit or a sealing device by closing the conduit opening. The flow tube safety device is provided with three sealing rings in annular grooves. (D.C.C.)

20890 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Obertelli, John David; Campbell, Ronald Hugh; Holmes, John Arthur Godfrey; Saunders, Alan Charles Anthony (to United Kingdom Atomic Energy Authority). British Patent 1,105,289. Mar. 6, 1968. Filed Aug. 23, 1965.

The description of a boiling reactor is presented. The fuel assembly consists of a cluster of end supported, spaced fuel elements with transverse bracing grids. Selected bracing grids serve as deflecting waves for coolant flow. Some of the vanes direct coolant flow towards the radially outer fuel elements of the cluster, and the other vanes extract liquid phase coolant from the vapor phase coolant and direct it to radially outer fuel element surfaces. Coolant channels consist of ferrules contained within a peripheral rim of each fuel element. (D.C.C.)

20891 NUCLEAR REACTOR. Margen, Peter Heinrich Erwin (to Aktiebolaget Atomenergi). British Patent 1,105,559. Mar. 6, 1968. Priority date Mar. 12, 1965, Sweden.

The description of a boiling reactor is presented. The reactor consists of a pressure vessel with a water space in the lower portion and a steam space in the upper portion. A thin-walled shroud surrounds the steam space, and a gas is injected into the space between the shroud and the wall of the pressure vessel. A water seal serves to separate the steam from the gas. (D.C.C.)

20892 NUCLEAR REACTORS. Henderson, Gordon Taylor; Jackson, Fred (to United Kingdom Atomic Energy Authority). British Patent 1,105,477. Mar. 6, 1968. Filed Nov. 6, 1964.

The description of a gas-cooled reactor core is presented. The core consists of fuel elements stacked in vertical channels in a solid moderator. Some of the vertical channels have fuel elements stacked upon a support strut and are surmounted by a non-fissile member. The support strut and non-fissile member have pressure sensing chambers. The non-fissile member also serves as a hold-down weight for the core. (D.C.C.)

20893 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Butterfield, Colin Edgar; Haake, Nicholas (to United Kingdom Atomic Energy Authority). British Patent 1,105,359. Mar. 6, 1968. Filed Apr. 5, 1966.

The description of a refueling access assembly for a gas-cooled, graphite-moderated reactor with a concrete pressure vessel is presented. The refuelling access standpipes penetrate the wall of the pressure vessel, and each standpipe is joined to at least one other standpipe to restrain axial movement. The standpipes are also keyed to the concrete where they penetrate the pressure vessel walls for additional stability. (D.C.C.)

20894 HETEROGENEOUS NUCLEAR REACTORS. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,105,194. Mar. 6, 1968. Priority date Aug. 13, 1965, Germany.

The description of a heterogeneous reactor heat transfer system is presented. A heat exchanger is connected on the inlet side of the reactor and also to the reactor outlet. The arrangement allows steam produced in the reactor to pre-heat the feed water, which results in the steam being condensed. The heat exchanger is provided with a pump to feed the condensate to the inlet of the heat exchanger for the feed water. (D.C.C.)

Marine and Portable Power Reactors

Refer also to abstracts 18995 and 19588.

20895 (HIT-3583-88(Add.)) ADDENDUM TO FINAL DESIGN REPORT FOR THE LOW ENRICHED PM REPLACEMENT CORE. Baer, Robert (Hittman Associates, Inc., Columbia, Md.). Dec. 1967. Contract W-7405-eng-26; Subcontract 2900. 109p. (HIT-268). Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

ARMY REACTORS (PM-1)—core burnup of, analysis of Low Enriched Replacement; core configuration for, description of Low Enriched Replacement

REACTOR FUEL ELEMENTS—burnup of PM-1 Low Enriched Replacement Core, analysis of; assembly configuration for PM-1 Low Enriched Replacement Core; bowing analysis of PM reactors, computer programs for

HEAT TRANSFER SYSTEMS—temperature distributions in PM reactor fuel assemblies, effects of coolant flow on

THERMAL STRESSES—analysis in PM reactor core structures

STRAIN—analysis in PM reactor core structures

FISSION PRODUCTS—burnup release of gaseous, analysis of PM reactor fuel assemblies (H.D.R.)

20896 REACTOR ANCILLARY CIRCUITS OF THE NUCLEAR RESEARCH SHIP "OTTO HAHN". Stermann, H. P. (Babcock and Wilcox-Dampfkesselwerke, Oberhausen, Ger.). Kerntechnik, 10: 20-31(Jan. 1968). (In German).

The functional layout and operation of the reactor ancillary circuits of the nuclear research ship "Otto Hahn" are described. These circuits are connected directly to the primary system and ensure its safe and correct operation, including emergencies. They supply the primary system with primary water, purify this water and monitor its quality. They safeguard the primary system against excessive pressure build-ups, ensure emergency cooling and feeding, and prevent the escape of primary steam leakage and blow-offs to the outside. (auth)

20897 GERMANY APPROACHES NUCLEAR MERCHANT MARINE STATUS. Motor Ship, 48: 383-5(Dec. 1967).

Progress with the 10,000 shp nuclear-propelled ore carrier, passenger, and research ship "Otto Hahn" is reported. A brief description of the ship is given, and the leading particulars are listed. (UK)

20898 NAVAL NUCLEAR PROPULSION PROGRAM, 1967–68. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETIETH CONGRESS, FIRST AND SECOND SESSIONS, MARCH 16, 1967–FEBRUARY 8, 1968. Washington, D. C., Joint Committee on Atomic Energy, 1968. 518p. GPO $1.50.

Major technological advances in the development of nuclear propulsion plants for U. S. submarines and surface warships are examined. The advantages and needs for further development of nuclear propulsion for naval striking forces are discussed. (H.D.R.)

Rocket and Space Reactors

Refer also to abstracts 18967 and 19478.

20899 (UCRL-70797) EFFECTS OF CROSS-SECTION UNCERTAINTIES IN COMPACT SPACE POWER REACTORS. Brown, P. S.; Watts, J. L.; Doyas, R. J. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 28, 1968. Contract W-7405-eng-48. 10p. (CONF-680307-3). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

The effects of cross-section uncertainties have been studied in compact (20 kWe to 10 MWe) space power reactors. Three systems were considered having core sizes of 12, 78, and 525 liters and median fission energies of 560, 380, and 200 keV, respectively. Each core contained UN fuel, W–Re–Mo alloy cladding, and Li coolant within a Ta pressure vessel and BeO reflector. The cross sections of each material were perturbed 10%, and downscatter terms of each scattering matrix were increased 50%. Reactivity effects were computed for these perturbations with the ZOOM diffusion code with tight convergence. The size of perturbations was varied to demonstrate linearity. Because of hardness of the spectra, the perturbations had significant effects only above 10 keV. The additivity of groupwise and materialwise cross-section changes was examined to determine interaction between the various perturbations. Calculations were done to determine the sensitivity of the spectrum shape, fission ratios, reactivity worths, and neutron lifetime to cross-section uncertainties, and to evaluate whether measurement of such parameters in critical experiments can be useful in testing cross-section data. (auth)

20900 (WANL-TME-1154) CLUSTERED NUCLEAR ENGINE STUDY: SUB-POWER RANGE. Thompson, C. A.; Kim, C-K (Westinghouse Electric Corp., [Pittsburgh, Pa.] Astronuclear Lab.). June 17, 1965. Subcontract NP-1. 68p. Dep. CFSTI.

The computer simulation of clustered nuclear engines in the sub-power range, and the study of clustered engine nuclear startup transients are described. The significance of nuclear coupling between cores on the control of clustered engine operation was evaluated, problem areas were identified, and a control system was designed conceptually. An analog simulation of a NERVA reactor for sub-power range was developed. By combining two or three identical models which include reactivity coupling of cores and neutron detector coupling, clustered engines of two or three modules were simulated. Reactivity coupling coefficients and neutron detector coupling were used as parameters. Utilizing the analog simulation developed, two modes of transient runs were made: Mode A, where both reactors have closed control loop and the same power or drum position demand, and Mode B, where the active reactor has a closed control loop and follows a given power or drum position demand, while the control drums of the passive reactors are held at a preselected shim position. Three groups of studies were made: parameter studies, KIWI-NRX reactor-type automatic startup studies, and sequential startup studies. The studies show that the nuclear startup of two or three clustered nuclear rocket engines may be accomplished by a number of different procedures. Two configurations were considered for the clustered engine system currently of interest: three engines located 33 feet apart in a triangular array, and a three-in-line configuration with the engines separated by 33 feet. The subpower range studies show that either automatic nuclear startup of the NRX-type or startup using closed control loops may be used with these systems. A procedure of the Mode A type, the Mode B type, or sequential startups can be used. (auth)

20901 A NEW FORMULATION OF THE THERMODYNAMIC LIMITS ON THE PERFORMANCE OF CHEMICAL AND NUCLEAR ENGINES. Hammitt, A. G. (TRW Systems, Redondo Beach, Calif.). J. Spacecraft Rockets, 5: 276-81(Mar. 1968).

The thermodynamic limits for engines which do not reject heat to the environment are described. Results for nuclear engines show that the maximum values of specific impulse are considerably greater than that obtained by an adiabatic expansion of the propellant from the temperature of the heat source. (D.C.C.)

Process Heat and Desalination Reactors

20902 (ORNL-NDIC-3) INDEXED BIBLIOGRAPHY OF NUCLEAR DESALINATION LITERATURE-1. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 61p. Dep. CFSTI.

Abstracts are given for approximately 260 published articles related to the nuclear desalination of seawater. The body of the report is a copy of information stored in a computerized storage and retrieval system for the Nuclear Desalination Information Center (NDIC) at the Oak Ridge National Laboratory. The abstracts are grouped in nine categories (and repeated if they fall into more than one category). An author and a key-word index to the articles referenced is provided. The key-words, which identify the content of the articles, were chosen from a thesaurus developed by NDIC. (auth)

20903 COOLANT SYSTEM SAFETY OF THE REACTORS BN 350 AND BOR. Pineiski, A. A.; Bagdasarov, I. E.; Mitenkov, F. M.; Pinchasik, M. S.; Pischin, W. K. Bull. Inform. Sci. Tech. (Paris), No. 122, 53-60(Jan. 1968). (In French).

Possible accidents which can occur in the thermal circuits of BN 350 and BOR are analysed. These accidents can lead to the shut-down of the coolant flow in the reactor, in the liquid metal circuits and in the steam circuits. Precautions taken in the facilities to assure the safety of heat extraction are studied. (auth)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 18947, 19093, 19537, 19538, 20903, and 20975.

20904 (ANL-7340) SUMMARY REVIEW OF FLOWMETERS SUITABLE FOR MEASURING SODIUM FLOW AT TEMPERATURES UP TO 1200°F IN THE FAST FLUX TEST FACILITY (FFTF). Popper, G. F.; Wiegand, D. E.; Glass, M. C. (Argonne National Lab., Ill.). Dec. 1967. Contract W-31-109-eng-38. 32p. Dep. CFSTI.

A comprehensive evaluation of prototype fuel assemblies for sodium-cooled fast-breeder reactors depends, in part, on the development of flowmeters capable of reliable operation under conditions anticipated in the FFTF core. Presented are a review and an evaluation of published information on various flow-monitoring devices and concepts with potential for application in the FFTF. 56 references. (H.D.R.)

20905 (BNWL-624, pp 5.1-16) PLUTONIUM RECYCLE TEST REACTOR (PRTR). (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The recovery of the Fuel Element Rupture Test Facility incident was completed and the facility was returned to service. All nuclear critical experiments were completed for the Batch Core Experiment and the FERTF program. Modifications to the PRTR were made to improve control and safety features and to increase the power level. Experimental and analytical studies were performed to determine boiling burnout limits for an 8-rod fuel element in the FERTF. The physics characteristics of two types of fuel elements

were investigated for various enrichments and rod sizes to determine the feasibility of a thorium loading in the PRTR. (H.D.R.)

20906 (BNWL-SA-1485) EFFECTS OF UNCERTAINTIES IN NUCLEAR DATA ON EXPERIMENTAL AND CALCULATED REACTOR BURNUP. Christensen, D. E.; Liikala, R. C.; Matsen, R. P.; Prezbindowski, D. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 26, 1968. Contract AT(45-1)-1830. 12p. (CONF-680307-4). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

Inaccuracies in the basic nuclear data information result in uncertainties in the experimental determination and the theoretical prediction of reactor burnup. The experimental determination of reactor burnup requires measuring the number of fissions that occur and the changes in the fuel isotopic composition as a function of exposure. These data are also utilized to deduce ratios of effective cross sections. A fundamental quantity required in the determination is the content of a fission monitor (e.g., ^{137}Cs, ^{148}Nd, etc.). Uncertainties in yield, half lives, and branching ratios of the monitor lead to uncertainties in the number of fissions. This results in uncertainties in determining the isotopic composition of the fuel and the ratios of effective cross sections as a function of exposure. The measured isotopic composition changes along with the deduced ratios of effective cross sections are used to compare to theoretically predicted values to check the accuracy of the theoretical methods. The theoretical prediction of reactor burnup is based upon the use of cross sections. Uncertainties in the basic cross sections lead to uncertainties in calculated results. Results are given for plutonium fuel (Al–Pu) irradiation experiments conducted in the Plutonium Recycle Test Reactor (PRTR).

20907 (INR-821/IXA/PR) SPECTRUM INDEX Lu:Dy MICRODISTRIBUTION MEASUREMENTS IN "ANNA" REACTOR LATTICES. Jozefowicz, E. T.; Adamski, L.; Jozefowicz, K. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 11p. Dep.

The detailed results of spectrum index Lu:Dy microdistribution measurements in the elementary cells of ANNA reactor lattices are given and are compared with theoretical calculations using K-7 THERMOS Code. (auth)

20908 (ORNL-4169(Vol.2)) THE OAK RIDGE RESEARCH REACTOR: SAFETY ANALYSIS. Binford, F. T.; Stone, R. S.; Webster, C. C. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 69p. Dep. CFSTI.

Appendixes by R. S. Stone and C. C. Webster.

A safety analysis is presented of the consequences of potential accidents to the ORR at an operating power level of 45 MW. The analysis deals primarily with potential environmental contamination and its attendant hazards to the local as well as the general population from a massive release of fission products from the ORR fuel in a meltdown accident. The types of accidents that would cause fuel meltdown are examined in detail, and less severe accidents involving handling and storage of fuel or radioactive material are discussed. It is concluded that even a 100% meltdown of the ORR core would not produce serious off-area environmental contamination or catastrophic results within ORNL. (H.D.R.)

20909 (ORNL-TM-2095) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT FOR NOVEMBER–DECEMBER 1967. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). Feb. 5, 1968. Contract W-7405-eng-26. 137p. Dep. CFSTI.

URANIUM OXIDES UO_2—fuel elements of, fission product analysis from failures of
REACTOR FUEL ELEMENTS—failure of uranium oxide (UO_2), fission product analysis from
IODINE-130—determination of tracer, from foiled uranium oxide (UO_2) fuel elements
IODINE-131—determination of tracer, from Zircaloy-2 clad uranium oxide (UO_2) fuel element failure
REACTOR FUEL ELEMENTS—release of fission products from metal-clad uranium oxide (UO_2), during burnout
BROWNS FERRY POWER REACTOR, UNIT I—fuel element burnout in, fission-gas analysis of
IODINE—solubility in air and aqueous solutions at 25°C, measurement of equilibrium distribution coefficients for
METHANE, IODO—sorption of, effects of pH and relative humidity on
NUCLEAR SAFETY PILOT PLANT—spray system in, half-life measurements for iodine and iodomethane cleanup of
IODINE—removal in NSPP spray system, half-life measurements for testing of
METHANE, IODO—removal using NSPP spray system, half-life measurements of
HYDROGEN—production of radiolytic, effects of dose rate in sprays on
CHARCOAL—sorptive properties for iodomethane, effects of humidity and temperature on
REACTOR SAFETY EXPERIMENTS—fission product removal in LOFT, effects of spray injection on
ANTIMONY-125, TIN-113, COBALT-60, IODINE—removal from LOFT condition aerosols, effects of spray injection on
GRAPHITE—effects of reaction with superheated steam at 1000 to 1300°C on
STEEL—fracture behavior of 12 in. thick ASTM A533, effects of austenitizing from 1600°F on
REACTOR SAFETY—description of CHORD-S data bank system for information storage for
MOLTEN SALT BREEDER REACTOR—safety studies for, description of (D.C.C.)

20910 (ORNL-TM-2147) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT, OCTOBER, NOVEMBER, AND DECEMBER OF 1967. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). Feb. 28, 1968. Contract W-7405-eng-26. 48p. Dep. CFSTI.

Operating experience, instrument and process maintenance, and experiment activities are tabulated and items of particular interest are indicated. Special tests conducted included efficiency tests of off-gas and cell-ventilation systems filters and reactivity and flux change measurements on a cadmium-boron neutron filter installed in the fuel region of the core. The sudden increase in cadmium contamination of reactor cooling water and the checks of a slightly corroded cadmium shim rod thought to be responsible for the contamination are described in detail. (H.D.R.)

20911 (RT/FI-(67)30) ANALISI A MOLTIGRUPPI PER LA DETERMINAZIONE DEL MIGLIOR INDICE SPETTRALE IN MISURE DI K_∞ COL METODO DELLA REATTIVITA NULLA. (Multigroup Analysis for the Determination of the Best Spectral Index in the Measurement of k_∞ by the Method of Null Reactivity). Casali, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 36p. (In Italian). Dep.

A study to decide what detector or combination of detectors which will give the best information about the neutron spectrum matching k_∞ measurements performed by the null reactivity method is presented. Test configurations include: graphite moderated lattices with natural uranium as fuel; and heavy water moderated lattices with natural or slightly enriched (^{235}U or ^{239}Pu) uranium as fuel element. Results show that the CaR of a resonance detector is as accurate as the $^{235}U/^{238}U_{sep}$. The CaR measurements were performed for Au, Mn, and for ^{235}U fission chamber for two neutron spectra. The variations of these spectral indexes were the same order of magnitude. (auth)

20912 (ZFK-RN-31, pp 28-44) PERENOSNYI IONOOBMENNO-MEKHANICHESKII FIL'TR DLYA OCHISTKI VODY V REAKTORNYKH USTANOVKAKH. (Portable Ion Exchanger and Mechanical Filter for the Purification of Water in Reactor Plants). Begushevski, Z.; Tsemnevski, S. (Institute of Nuclear Research, Warsaw (Poland)). (In Russian).

The design and hydraulic parameters of the mobile unit for demineralization and purification of the water in a reactor primary system are given. Filter construction is based on the interdependence of the chemical characteristics of reactor water upon the operational requirements for the reactors. (auth)

20913 (ZFK-RN-31, pp 45-8) EINIGE NEUE VORRICHTUNGEN IM KUEHLSYSTEM DES REAKTORS WWR-S. (Some New Devices in the Cooling System of the WWR-S Reactor). Kavan, K. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). (In German).

The secondary circuit of the WWR-S reactor is checked for leaks during refueling and necessary reactor rest states. The color-indicator method is employed for leak determination. A simple device is described to facilitate the removal of the ion-exchange matter from the average filter unit. (auth)

20914 (ZFK-RN-31, pp 55-68) MITTEILUNGEN UEBER NEUERE ARBEITEN AM ROSSENDORFER FORSCHUNGSREAKTOR WWR-S. (Information Regarding Recent Work at the Rosendorf Research Reactor, WWR-S). Westphal, D. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)). (In German).

Improvements on the WWR-S reactor include: description of the siphoning principle to remove ionite without material changes of the filter container construction for 10 MW operation; testing of a small ion exchange filter, type Mofatit MBR; pH-value correction of small potassium-base ion exchange filter from VEB Farbenfabrik Wolfen; and sterilization tests to determine microorganism content in the primary circuit. (auth)

20915 (ZFK-RN-31, pp 110-21) ELEKTROFOREZNYI FIL'TR DLYA OCHISTKI REAKTORNOI VODY. (Electrophoresis

Filter for Purifying Reactor water). Ganzha, V. D.; Kaminker, D. M.; Konoplev, K. A.; Saikov, Yu. P.; Egorov, A. I.; Kolyadin, A. B.; Rodionova, R. N.; Trenin, V. D.; Sharov, V. T. (Akademiya Nauk SSSR, Moscow. Fiziko-Tekhnicheskii Institut). (In Russian).

About 6 grams of slightly soluble aluminum hydroxide are formed per day by corrosion in the water of the WWR-M reactor. Complete water purification is obtained by means of an electrophoresis filter unit. With a total volume of 10.7 liters and a negligible flow resistance the unit features simple operation with an effective water output of 250 to 500 liters per hour. (auth)

20916 (ANL-Trans-556) EXPERIMENTAL STUDY OF NEUTRON CHARACTERISTICS IN FAST MULTIPLYING MEDIA, USING THE THERMAL-FAST CRITICAL ASSEMBLY "ERMINE." Bouchard, J.; Mougniot, J. C.; Vidal, R. Translated for Argonne National Lab., Ill., from Paper Presented at Conference on Fast Reactor Physics and Related Safety Problems, Karlsruhe, Germany, Oct. 30–Nov. 3, 1967. 22p. (CONF-671043-15). Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

The fast-thermal ERMINE assembly in the MINERVE reactor is described. Reactivity and flux measurements and measurement techniques are described. Doppler effect and neutron importance measurements are discussed. Spectral index values are tabulated; results of reactivity measurements are listed. Data are shown graphically. (M.L.S.)

20917 (JPRS-44332) EXPERIENCE GAINED IN THE OPERATION OF THE VVR-M REACTOR. Translated from pp 1-18 of Izuchenie i Uluchshenie Ekspluatatesionnykh Vozmozhnostey i Opyt Ekspluatatsii Reaktora VVR-M Instituta Fiziki AN UkSSR, Kiev, 1963. 23p. CFSTI.

The problems associated with the VVR-M reactor are discussed. The reactor parameters and improvements in service capabilities are also presented. (auth)

20918 DYNAMICAL STRESS AMPLITUDE IN A FAST PULSE REACTOR. Kolesov, V. F. Inzh.-Fiz. Zh., 14: 134-7(Jan. 1968). (In Russian).

The results of numerical calculations of dynamical stresses in the elements of a fast pulse reactor core are presented. In the calculations, the reactor version is used in which processes are determined by a single oscillation system with one degree of freedom. The dependence of the stress amplitude upon a pulse shape is investigated by the example of spherical envelopes with several oscillation frequencies. It was obtained from the analysis of the calculated data that the maximum stresses in the elements depend only upon complete heating of the element in pulse and upon the product of the eigenfrequencies of the element by the pulse width. Analytical expressions for the stresses in the free oscillation stage are presented. (auth)

20919 DESIGN AND CONSTRUCTION OF A LIQUID HELIUM FACILITY IN THE ARGONNE CP-5 REACTOR. Klank, A. C.; Blewitt, T. H.; Minarik, J. J.; Scott, T. L. (Argonne National Lab., Ill.). Bull. Inst. Int. Froid, Annexe, 373-81(1966).

Description of the facilities in the Argonne CD-S reactor for fission and thermal neutron effects on materials at liquid helium temperatures is presented. Refrigeration is provided by a helium refrigerator with a capacity of approximately 100 W at 4.2°K. Measurements made at 5°K of uranium growth, yield stress in Cu, and resistivity of several metals and alloys are discussed. (auth)

20920 IRRADIATIONS IN MATERIALS-TESTING REACTORS. Bugl, Josef (Joint Nuclear Research Center, Ispra, Italy). Euratom Bull., 6: 98-103(Dec. 1967).

A summary of European materials-testing reactors and their characteristics are presented in tabular form. The Petten high flux reactor is described; a cutaway is shown; characteristics are listed. (M.L.S.)

20921 MECHANICAL SYSTEMS DESIGNED FOR SAFETY IN ISRAELI RESEARCH REACTOR BUILDING. Agnon, S. (S. Agnon and Partners Consulting Engineers, Haifa, Israel). Heat., Piping, Air Cond., 39: 137-45(Oct. 1967).

The containment systems for the Isreal Research Reactor IRR-1 are described. The descriptions include: cooling and cleaning systems; vent tube systems; waste disposal; air conditioning; and hydrogen exhaust systems. (D.C.C.)

20922 EVALUATION OF REACTOR KINETIC EXPERIMENTS WITH AN EL-X8 ELECTRONIC COMPUTER. Dragt, J. B. (Reactor Centrum Nederland, Petten). Atoomenergie Haar Toepass., 9: 246-51(Nov. 1967). (In Dutch).

The computer is used off-line and punched or magnetic tape is used for information storage. Three applications are discussed. In the first one the results of rod-drive experiments are used to compute the reactivity as a function of time. In the second one the results of periodic injection of a neutron pulse are analyzed and adapted to exponentail decay of the neutron density with the least-squares method. 4 counters in differents sites in the reactor can be used simultaneously. Thirdly, evaluation of the autocorrelation function of the fluctuations in the neutron density is described. Examples are given. (JJTB)

20923 DETERMINATION OF REACTIVITY WORTHS AND PHOTONEUTRON EFFICIENCY IN ROD DROP MEASUREMENTS. Arcipiani, B.; Birkhoff, G.; Bondar, L.; Hage, W. (EURATOM-CCR, Ispra, Italy). Energ. Nucl. (Milan), 15: No. 2, 56-7(Feb. 1968).

The procedure used to assess the reactivity worth and the photoneutron efficiency in rod drop measurements performed on two heavy water-moderated reactors at Ispra is described. The two reactors were the ISPRA-1 reactor, with a strong constant background source, and the ESSOR reactor at zero power, with a core loaded in the driver zone only. Both reactors use highly enriched ^{235}U fuel elements. (auth)

20924 STATISTICAL AND PULSED EXPERIMENTS IN ORGANIC MODERATED AND REFLECTED ASSEMBLIES. Pacilio, N. (CNEN, Rome). Energ. Nucl. (Milan), 15: No. 2, 45-55(Feb. 1968).

A survey of theoretical studies and experiment applications regarding noise and pulsed techniques is presented and several results obtained for various organic moderated and reflected assemblies of the ROSPO reactor are given. A new experimental statistical procedure—the endogenous pulsed source method—has been applied in order to determine prompt neutron decay eigenvalues and reactivity coefficients related to a multiplication interval going from criticality to a minimum of −$14. The achieved results have been compared with similar determinations realized by three other statistical procedures, by pulsed neutron experiments in critical, slightly subcritical and very subcritical assemblies. The validity range of each technique is consequently defined with respect to many others. Some aspects of interpretation of the experimental data are also discussed. (auth)

20925 MEASUREMENT OF THE VOID COEFFICIENT OF REACTIVITY. Fujiie, Yoichi (Hitachi Zosen, Ltd., Japan); Mori, Michiaki; Matsui, Tsuneo; Miyazaki, Keiji. Nippon Genshiryoku Gakkaishi, 10: 58-65(Feb. 1968). (In Japanese).

An experimental study of the void coefficient of reactivity in HTR was carried out. The experiment consisted of an out-of-pile experiment on void ratio calibration and an in-pile experiment on reactivity measurement. A stream of nitrogen gas was introduced through a pipe to the bottom of a fuel channel to produce a rising column of void bubbles. The reactivity was derived from either rod position or positive period. The local void coefficients measured were: single channel void coefficient; two channel void coefficient; and three channel void coefficient. The average void coefficient of HTR was determined to be $\Delta k/k = -1.4 \times 1.07 \times 10^{-3}$/% void. (auth)

20926 MITR: RESEARCH REACTOR. Thompson, T. J. Nucl. Safety, 9: 157-60(Mar.-Apr. 1968).

The Massachusetts Institute of Technology Research Reactor technical specifications are discussed as related to prevention of reactor accidents to illustrate the concepts of naming and choosing limiting values of the primary safety parameters and the interrelation between them. (auth)

20927 APPLICATION OF THE PSEUDO RANDOM BINARY SIGNALS TO JRR-3 HIGH POWER DYNAMICS MEASUREMENTS. Hara, Masao; Usui, Hozumi; Fujii, Yoshio; Suda, Nobuhide (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 5: 79-85(Feb. 1968).

The maximum period sequence binary signal has been applied to measurements of the JRR-3 frequency response at 10 MW. Three measurements have been made to cover the frequency range of 0.003 to 10 radians/sec. The measurements were readily made when the reactor temperature was in equilibrium. Even when it was not, and the reactor power was varying slowly, a power drift compensating system made it possible to carry out accurate measurements. The results obtained under equilibrium and non-equilibrium conditions agreed well with each other. A simple mathematical model has been used to predict the JRR-3 high power dynamics. The frequency response computed with the use of this model also agreed fairly well with the experimental data. (auth)

Production Reactors

20928 COMMENT ON THE OPTIMAL COSTS OF ISOTOPES. Ruby, L. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 60: 354(Apr. 1968).

The minimum cost of radioisotope production has been recently determined through application of Pontryagin's principle. The cost function which was minimized is, $S = a \int_0^t [1 + \{\phi(t)/b\}^\xi]dt$. Although a, b and ξ are arbitrary positive constants, the problem was solved only for $\xi > 1$. It is pointed out that Pontryagin's principle also determines a solution for $\xi \leq 1$. In the latter case, the solution calls for maximum flux throughout the irradiation. (auth)

20929 A FURTHER NOTE ON OPTIMAL COSTS OF ISOTOPES. Eckhoff, N. D.; Fan, L. T.; Kimel, W. R. (Kansas State Univ., Manhattan). Nucl. Instrum. Methods, 60: 355(Apr. 1968).

This note is written in response to the comment by Ruby, who wishes to extend the results of the authors' original work by considering the case of $\xi \leq 1$ in the objective function, $S = a \int_0^T [1 + \{\phi(t)/b\}^\xi]dt$. The minimization of S results in the minimum cost policy for radioisotope production. (auth)

Reactor Theory, Components, Fuels and Accessories

Refer also to abstracts 19019, 19025, 19028, 19030, 19038, 19078, 19080, 19120, 19212, 19506–19508, 19526, 19528, 19571, 19587, 19598, 19608, 19609, 19618, 19620, 19622, 19642, 19646, 19649, 19669, 19670, 20404, 20407, 20412–20414, 20417, 20419, 20420, 20424, and 20665.

20930 (AEEW-R-219) PERTURBATION METHOD FOR MULTIGROUP NEUTRON TRANSPORT CALCULATIONS IN PLANE LATTICES. James, M. F.; Matthews, J. D. (Atomic Energy Establishment, Winfrith (England)). Nov. 1962. 43p. Dep. CFSTI. UK.

A simple and accurate method was derived and tested for the calculation of k-effective and the multigroup fluxes of an infinite, periodic, plane lattice of small cell width. Algebraic formulae were obtained for the difference between the values of these quantities for the lattice and those for the homogeneous infinite medium with the same average composition. Comparison between this method and the discrete ordinates and collision probability methods for a particular numerical example showed that it is at least as accurate as either of the latter for the type of cell considered, and yet involves considerably less computation. (UK)

20931 (AHSB(S)R-146) THE GEM 4 CODE. Longworth, T. C. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). 1968. 67p. Dep. CFSTI. UK 10s. 0d.

The differences between the computer program GEM 4 and its predecessor GEM 3 are described. Primarily, the changes concern the output. Revised methods are employed for estimating k_{eff}, and the statistical analysis of results has been modified. These changes have resulted in a slightly altered format for the punched output. (D.C.W.)

20932 (BNWL-515) PROGRAM ABH: THE MODIFIED ABH METHOD OF CELL HOMOGENIZATION FOR TEMPEST. Skeen, D. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1967. Contract AT(45-1)-1830. 36p. Dep. CFSTI.

The computer program ABH is presented. The program represents the disadvantage factor theory to be used in conjunction with program TEMPEST to produce cell cross sections for broad-group constants codes. The modifications to the Amouyal, Benoist, and Horowitz theory allow for the use of cladding surrounding the fuel instead of a void region. The program is in FORTRAN IV for the Univac 1107-8 computer. (D.C.C.)

20933 (FEI-77) TEOREMA OB INTEGRALE REAKTIVNOSTI KRITICHESKOGO REAKTORA. (Reactivity Integral Theorem for a Critical Reactor). Stumbur, E. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1967. 12p. (In Russian). Dep.

A theorem is derived for relating the reactivity integral coefficients for a critical reactor with the values of the medium property gradients, or with the boundary reactivity coefficient values in the case of a homegeneous zone reactor. The proof is given on the basis of the general critical reaction in which all the values are energy-dependent. The theorem is limited only by the requirements of convexity and homogeneity of the inner reactor boundary. (JPRS)

20934 (GA-8462) LATTICE PHYSICS STUDIES. Quarterly Progress Report for the Period Ending December 31, 1967. Trimble, G. D.; Gozani, T.; d'Oultremont, P.; Preskitt, C. A. (Gulf General Atomic, Inc., San Diego, Calif.). Jan. 15, 1968. Contract AT(04-3)-167. 47p. (EURAEC-1981). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Calculations of the single rod and lattice of uranium rods with water-to-uranium ratio of 4.18 have been completed. The calculations were made using the one-dimensional transport theory code 1DF. The experiment designed to measure the magnitude of any spectral distortion due to a reentrant hole has been performed. These data are now being analyzed. A code, GAMET, has been written, which corrects the measured time-dependent spectrum for the mean emission time of the neutrons. This code has been checked and is now operational. The experimental data for the single uranium rod and the 1.3-in. pitch of uranium rods have been reduced by both the conventional method using the HECTO code and the more sophisticated code GAMET. Preparations have been made for the spectral measurements in a tighter packed uranium lattice. A 2.06 water-to-uranium ratio lattice with a 1.0-inch pitch has been chosen. Calculations have been performed for the tighter packed uranium lattice using the one-dimensional transport theory code 1DF. (auth)

20935 (KAPL-P-3400) ADI ITERATION; THEORY AND APPLICATION TO REACTOR CRITICALITY CALCULATIONS. [Wachspress, E. L.] (Knolls Atomic Power Lab., Schenectady, N. Y.). [1968]. Contract W-31-109-eng-52. 10p. (CONF-680405-1). Dep. CFSTI.

From 20th Symposium on Applied Mathematics, Durham, N. C.

A basic iterative procedure is applied to the Chebyshev minimax theory for solution of the elliptic boundary value problems which occur in reactor criticality calculations. The iterative procedure is formulated by a tri-diagonal matrix for computation of the lower eigenvalue bounds. The eigenvalue bounds are then applied to the Chebyshev minimax theory to yield eigenfunctions of the differential operator that are separable. 13 references. (M.L.S.)

20936 (ZFK-RN-31) II. INTERNATIONALE KONFERENZ "WASSERPROBLEME AN KERNREAKTOREN" 10–13 NOVEMBER 1964 IN DRESDEN. (2nd International Conference on Water Problems of Nuclear Reactors, Dresden, Germany, November 10–13, 1964). Westphal, D. (comp.) (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)). Oct. 1965. 317p. (In German and Russian). (CONF-641135). Dep.

Included are twenty-two papers dealing with the topic of water coolant decontamination in nuclear reactors. Separate abstracts are provided for twelve of the papers. Ten of the papers have been previously abstracted for NSA as: 20: 24678; 20: 40465; 20: 40464; 19: 14857; 19: 44055; 20: 31682; 19: 27740; 19: 40124; 19: 26229; and 20: 36408. (D.C.C.)

For abstracts of individual papers see: 20826, 20827, 20912–20915, and 20937–20942.

20937 (ZFK-RN-31, pp 122-42) EINFLUSS DER KORNGROESSE AUF DEN WERT DER NUTZBAREN KAPAZITAET VON VARION KS. (Influence of Grain Size on Useful Capacity of Varion K,S,). Ambrus, S. (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). (In German).

Theoretical and practical examinations of the strongly acid Hungarian cationite Varion KS were undertaken to study its capacity and its stratum resistance at differing flow speeds as a function of grain size. Diffusion constants for the process were also determined with the aid of column tests. A method for simplifying the examinations to determine the expected capacity of the ion exchange is described. (auth)

20938 (ZFK-RN-31, pp 143-7) METODIKA OPREDELENIYA POLNOI OBMENNOI EMKOSTI SIL'NOOSNOVNYKH ANIONITOV TIPA "AV-17" I SODERZHANIYA V NIKH Cl' I CO_3'' FORM. (Method for the Determination of Complete Exchange Capacity of Strong Basic Type AW-17 Anionites and Its Cl'- and CO_3''-Form Content). Chernorotov, E. S.; Alekseev, B. A.; Bukhatkina, Yu. A. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). (In Russian).

A method for the determination of the complete exchange capacity of strongly basic type AW-17 anion exchangers together with their content of Cl- and CO_3-formations is presented. (auth)

20939 (ZFK-RN-31, pp 148-54) TEKHNOLOGNYA PEREVODA SIL'NOOSNOVNYKH ANIONITOV (TIPA "AV-17" I "AM") IZ KHLORIDNOI V GIDROKSIL'NUYU FORMU METODOM DVUKHSTADIINOI REGENERATSII. (Technology of the Conversion of Strong Basic Anionites (Type AW-17 and AM) from the Chloride Form to the Hydroxide Form Using Two-Stage Regeneration). Chernorotov, E. S. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). (In Russian).

A new technology of carrying over strong basic anion-exchangers from the Cl-form into the OH-form by successive treatment of the exchanger resins with solutions of NH_4CO_3 and NaOH is described. The method is cheaper and guarantees higher purity of chlorine than the exclusive treatment with NaOH. (auth)

20940 (ZFK-RN-31, pp 155-98) ISSLEDOVANIYA KINETIKI I DINAMIKI IONNOGO OBMENA V SIL'NORAZBAVLENNYKH RASTVORAKH. (Analysis of the Kinetics and Dynamics of Ion Exchange Processes in Strong Diluted Solutions). Alekseev, B. A.; Goldytskaya, Z. P.; Il'ina, D. S. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). (In Russian).

Additional information is given concerning the mechanism of exchange for strong diluted solutions (2×10^{-5} to 2×10^{-6} n) as well as the influence of temperature on the character of the rate of the processes limiting the exchange. A new method for the investigation of the ion-exchange-dynamics by filtering strong diluted solutions and some results obtained by this method are described. (auth)

20941 (ZFK-RN-31, pp 217-29) BEITRAG ZUR DEKONTAMINIERUNG VON WAESCHEREIABWAESSERN. (Contribution on Decontamination of Laundry Plant Waste Waters). Winkler, R.; Langecker, K. (Veb Atomkraftwerk, Rheinsberg (East Germany)). (In German).

Several clarifying variants of the waste waters from purification plants by means of chemical precipitation are analyzed. Clarified waste waters are obtained most feasibly by precipitation of $Al(OH)_3$ with an additive of activated carbon. For further decontamination the waste waters can be evaporated without formation of foam and boiler scale. (auth)

20942 (ZFK-RN-31, pp 284-98) METODIKI KHIMICHESKOGO ANALIZA VODY IZ KONTUROV YADERNO-ENERGETICHESKIKH USTANOVOK. (Methods of Chemical Analysis of Water on Atomic Energy Plants). Alekseev, B. A.; Goldytskaya, Z. P.; Chernorotov, E. S. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). (In Russian).

Methods of the chemical water analysis are described which are developed in the USSR used at the nuclear plants in the Institute of Atomic Energy. (auth)

20943 ISOTOPIC ANALYSIS OF NATURAL UO_2 FUEL IRRADIATED TO 22,000 MWd/MTU. THEORY VERSUS EXPERIMENT. Stachew, Joseph C. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Appl., 4: 206-16(Apr. 1968).

The U and Pu isotopic distributions of forty-five irradiated fuel rods of UO_2 are compared to theoretical predictions made using three-dimensional P-1 neutron diffusion techniques. The calculations are different in that normalization to experimental results is made only by use of the total core energy output and measured critical rod bank heights. This is in contrast to normalizing each individual fuel rod burnup to the experimental value and then investigating resultant isotopic distributions in the rod. The comparison indicates good agreement but identifies the need for a spatial spectrum variation of the ^{238}U epithermal resonance absorption cross section and improved time dependence of the ^{238}U and ^{239}Pu cross sections. (auth)

20944 IMPROVEMENT IN SECOND EXCURSION CALCULATIONS. Braess, D.; Kusters, H.; Thurnay, K. (Institut fuer Neutronenphysik und Reaktortechnik, Karlsruhe, Ger.). Bull. Inform. Sci. Tech. (Paris), No. 122, 61-83(Jan. 1968). (In French).

The calculation of second excursions is performed with a formalism developed by Bethe and Tait, improved by taking into account effects of delayed neutrons and Doppler feedback and applied to cylindrical cores. The parameters of the equation of state in the calculations of excursions are estimated by the kinetic theory of gases following the model proposed by H. Eyring. The critical data and the thermodynamic functions are obtained by an approximate partition function. The results obtained by the use of axial and spherical geometries are compared. The importance of a delayed Doppler feedback on the quantity of energy released is also estimated. (auth)

20945 PRESTRESSED CONCRETE CAISSONS FOR NUCLEAR REACTORS. Caine, Yves. Travaux, No. 367, 453-67 (July-Aug. 1965). (In French).

The concept of the coefficient of safety and its application to prestressed concrete vessels are examined, and the possible failure processes in such vessels are discussed. The economics of the use of passive reinforcing rods for deformation control are analyzed. Cracking safety and fracture safety criteria for a vessel section are calculated using elastic theory. These criteria are examined and the effect of the temperature gradient on thermal expansion, elasticity, thermal conductivity, shrinkage, and creep are discussed. Guidelines are recommended for the procedures involved in constructing prestressed concrete vessels. (H.D.R.)

20946 OPTIMUM NUCLEAR REACTOR CONTROL THEORY. Lewins, Jeffery; Babb, Albert L. Advan. Nucl. Sci. Technol., 4: 251-308(1968).

The basic theory of Pontryagin's treatment of optimal control of a reactor for efficient operation in a system is reviewed. The mathematical model of the system to which this optimum control theory is applicable is based on a finite number of ordinary differential equations. Application of the theory to the shutdown of a reactor subject to xenon poisoning is presented to illustrate the variety of problems and approaches that may be treated by the theory. The connection between the theory and dynamic programming as complementary methods of determining optimum control programs is examined. A generalization of the theory to encompass models of distributed rather than point systems is discussed to illustrate the wide range of applicability of the theory. (H.D.R.)

20947 A METHOD OF TRANSFORMING THE PROMPT DECAY CONSTANTS α_i INTO THE STATIC REACTIVITY ρ_i. Amano, Fumio (Electrotechnical Lab., Tokyo); Sunako, Katsuhiko. J. Nucl. Sci. Technol. (Tokyo), 5: 65-73(Feb. 1968).

An analytical method of transforming the prompt decay constants α_i into the static reactivity ρ_i is described. It is developed through the use of the time-dependent, two-group diffusion theory ignoring delayed neutrons under several assumptions. A generalized characteristic equation which relates the prompt decay constants to the effective multiplication constant can in general be derived by expanding the static fluxes into kinetic fluxes containing the fundamental and higher modes, and several approximated formulas for this equation have been obtained with the application of certain conditions. In particular, a formula that takes into account the change in the generation time is proposed as a most useful method for reactivity measurement. Error evaluation has been performed in regard to several approximate formulas, and some problems involved in numerical calculation have been examined. 15 references. (auth)

20948 FEEDBACK CONTROL OPTIMIZATION OF A SINGLE FLUID HEAT EXCHANGER OR NUCLEAR REACTOR. Watts, R. G. (Tulane Univ., New Orleans); Schoenhals, R. J. Nucl. Eng. Design, 7: 40-8(1968).

The performance of a single fluid heat exchanger is analyzed under conditions of proportional control of heat flux. The error is obtained from a single temperature probe whose axial location can be varied. The usual procedure is to place the probe at the outlet and to select the best proportional gain constant for this situation. However, results of this study show that simultaneous optimization of gain constant and axial probe location can produce large improvements in system performance. Quantitative results are given for the case of variable inlet temperature whose spectral power density is constant up to a high frequency limit, and is zero beyond this limiting value. A physical argument is suggested which relates optimum probe location to a single parameter defined in terms of system time constants. Many nuclear reactor systems can be regarded as single fluid heat exchangers for purposes of calculating outlet temperature dynamics, since the heat generation rate usually responds a great deal faster than the fluid temperature when a control rod position is changed. The general method outlined is also applicable to boiling water reactors in which the outlet void fraction rather than the outlet temperature is the controlled variable. (auth)

20949 SPHERICAL HARMONICS CONVERGENCE STUDIES FOR CRITICAL SPHERES. Callen, J. D.; Mingle, J. O. (Kansas State Univ., Manhattan). J. Nucl. Energy, 22: 173-85(Mar. 1968).

The use of spherical harmonics approximations of the monoenergetic Boltzmann neutron transport equation to determine the critical radius of a spherical reactor is considered, with emphasis placed upon the even-order approximations. Numerical computations indicate that, in terms of the prediction of a critical radius, the P_2 approximation is usually superior to the P_1 approximation. For higher order approximations the odd-order approximations are invariably superior to their corresponding even-order approximations. When Mark's vacuum-interface boundary conditions are used for a bare spherical reactor, or the appropriate interfacial boundary condition is applied to a reactor with a thick reflector, the even-order approximations provide a lower bound on the exact critical radius. In the same circumstances the odd-order approximations provide an upper bound. A particular weighted average of these counter convergent even and odd-order approximations is found to converge more rapidly than with the use of either independently. (auth)

20950 INTERFERENCE BETWEEN RESONANCES IN A SLAB LATTICE. Mannan, M. A.; Zweifel, P. F. (Univ. of Michigan, Ann Arbor). J. Nucl. Energy, 22: 139-52(Mar. 1968).

In calculating resonance absorption for one resonance the effect of neighbouring resonances is usually neglected. It is, therefore, customary to assume that the slowing-down flux takes its asymptotic value above the resonant energy and becomes independent of

both lethargy and space. When, however, the resonances are not widely separated, a resonance may lie in the region of energy oscillation due to other high-energy resonances. In this region the flux may depend on both lethargy and space. A method was developed for estimating the error involved. In this calculation the higher energy resonance replaced by a delta function sink, and the age-diffusion equation with modified source term was solved to obtain the lethargy and space-dependent flux. The resonance integrals were then calculated in the presence and in the absence of the higher energy resonance in an effort to estimate the importance of this effect. Various calculations of the effect of resonance interference have ignored spatial effects, but these may be important, particularly for tightly packed lattices. (auth)

20951 EXPECTED LEAKAGE ESTIMATOR APPLIED TO TIME-DEPENDENT NEUTRON TRANSPORT. Kschwendt, H.; Rief, H. (EURATOM, Ispra, Italy). J. Nucl. Energy, 22: 127-38(Mar. 1968).

The method of Expected Leakage Probability, applied to time-dependent Monte Carlo neutron transport calculations, is discussed in detail. It is shown that the efficiency of this method is much higher than that of the usual Analogue Monte Carlo technique, especially for the larger time-scale phenomena in small non-multiplying assemblies. The behavior of the time-dependent neutron leakage is calculated for monoenergetic neutrons and bare spheres, and the decay constants are compared with those obtained by other methods. The method of Expected Leakage Probability is also tested by calculating the leakage spectra and decay constants for a lead block exposed to a neutron pulse and comparing the results with the experimental values. (auth)

20952 COMPUTATIONAL TECHNIQUES AND PERFORMANCE CRITERIA FOR THE OPTIMUM CONTROL OF NUCLEAR SYSTEM DYNAMICS. Saluja, Jagdish K. Gainesville, Fla., Univ. of Florida, 1966. 165p.

Thesis.

The optimum control of the dynamics of nuclear systems and a associated a computational problems was investigated. Two systems were considered: nuclear reactor system, and a nuclear rocket engine system. For the first system, three problems were analyzed. The neutron density or reactor power is transferred from one steady state condition to another with a quadratic constraint on control rod movement. By varying the operating time and placing an inequality constraint on reactivity a form of minimum time control is obtained. The integral of quadratic form of error in desired neutron density is minimized with quadratic integral constraint on control rod movement. A fixed configuration optimum closed-loop control system is realized by letting control rod movement be a proportional plus integral function of neutron density error. The two-point boundary value problems (TPBVP) resulting by the application of optimization theory to point reactor models were obtained. A modified gradient technique was used to exploit the hybrid capabilities of modern analog computers. The results were compared with the solutions of this problem by the numerical of quasilinearization. In all of these, the convergence was obtained in no more than four iterations. In the examples considered here, the cost function was higher for the closed loop case as opposed to the open loop case. This is in general agreement with physical insight and previous results, since an assumed form of closed loop controller was used. The coefficients A and B in the control law are highly dependent upon the final time t_f, the system parameters, and the initial and desired final state. Variation in system parameters may, however, render the closed loop control better than the open loop control which does not change with changing system parameters. For the case of the nuclear rocket engine system, only a quadratic constraint on total reactivity was considered. The nuclear rocket engine was similar to the solid-core 25,000 MW, million pound thrust model developed by Smith and Stenning. Here, the results obtained for various start-up times and various desired power levels in terms of control needed and required cost, appear very reasonable. Also it was observed that if the pressure and the temperature time constants were increased from their normal values, the temperature response became somewhat sluggish. Possible improvements to this situation are suggested. (Disser. Abstr.)

20953 NUCLEAR REACTOR WITH FUEL ELEMENT COOLED BY BOILING WATER AND STEAM. Margen, Peter Heinrich Erwin (to Aktiebolaget Atomenergi). British Patent 1,103,248. Feb. 14, 1968. Priority date July 24, 1964, Sweden.

A reactor fuel element is made up of a body of fissile fuel having at least two opposed heat exchanging surfaces with fuel between them. One of the surfaces is arranged to be cooled by water that is heated to boiling by the fuel to produce steam that cools the other heat-exchange surface to yeild a superheated steam. A heat-insulating layer provided on at least part of one of the surfaces is so arranged as to direct the major portion of the heat to that surface of the fuel body that is most efficiently cooled. (B.L.M.)

20954 PROCESS AND APPARATUS FOR DISCHARGE OF FISSION GASES FROM NUCLEAR REACTOR FUEL ELEMENTS. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,103,217. Feb. 14, 1968. Priority date June 3, 1964, Germany.

Reactor fuel elements of the ceramic type are provided with an outlet device for fission gases. The outlet device includes a number of chambers connected in series to that part of the element containing the fuel and/or breeder substance. Each chamber interior is provided with a labyrinth system and is at least partially filled with an absorbent filling. These chambers are connected in series but are separated from each other by gas permeable partitions. The last chamber in the direction of flow is separated by a gas permeable partition from the cooling medium chamber. Excess pressure valves are arranged to serve as throttle devices for delaying the passage is the fission gases for a period of at least 10 days, preferably 60 days. During this delay period the intermixing of newly formed fission gases with fission gases whose radioactivity has partially died down is prevented. Before entering the outlet device, the fission gases are treated to separate condensable substances. (B.L.M.)

20955 NUCLEAR REACTOR CONTAINMENT SYSTEM AND RELIEF VALVE. (to Atomic Energy of Canada Ltd.). British Patent 1,102,907. Feb. 14, 1968. Priority date Aug. 9, 1965, United States.

A containment system for a nuclear reactor is made up of a gas-tight building surrounding the reactor, a vacuum building for receiving gas from within the reactor building, a conduit connecting the two buildings, and a pressure responsive relief valve in the conduit for connecting the vacuum and reactor buildings when the pressure in the reactor building exceeds atmospheric. The relief valve comprises a cylinder, ports defined in the cylinder, and a piston in the cylinder comprising a bobbin including first and second end plates. The first end plate is adjacent to one end of the cylinder and separates one end from the ports. The second plate is positioned beyond the ports. Means are provided that connect the ports to the vacuum building, that connect one end to the reactor building, and that serve to lead gas to the part of the cylinder defined beyond the second plate. The piston is positioned in dependence upon pressure in the part of the cylinder connected to the reactor vessel. (B.L.M.)

20956 JET PUMP ASSEMBLY IN A NUCLEAR REACTOR. (to General Electric Co.). British Patent 1,103,032. Feb. 14, 1968. Priority date Apr. 5, 1965, United States.

A jet pump for use in a reactor pressure vessel to circulate coolant through the core includes an elongated pump body having an inlet and outlet disposed in the pressure vessel, an elongated supply pipe disposed in the vessel alongside the pump body and having an end extending beyond the pump inlet, and a nozzle member releasably connected to the end of the supply pipe. The nozzle member is so positioned to direct a jet of driving fluid into the pump inlet. The first portion of the pump body, which provides the pump inlet, is releasably connected to the further portion of the pump body. These releasable connections provide for quick and easy removal and replacement of the nozzle and pump inlet, which are the elements subject to most wear. (B.L.M.)

20957 STEAM GENERATOR ARRANGEMENT HEATED BY REACTOR WATER FROM A NUCLEAR REACTOR. Dahlgren, Jons Arthur (to AB Rosenblads Patenter). U. S. Patent 3,344,776. Oct. 3, 1967. Priority date Oct. 14, 1964, Sweden.

The description of a steam generator- and heater-unit to be heated by hot reactor water of a nuclear reactor is presented. The steam generator- and heater-unit consists of a closed vertical elongated pressure vessel of circular cross-section; an upper tube wall and a lower tube wall extending horizontally in the vessel; and a vertical partition wall which divides the vessel into a steam generator space above the upper tube wall and a heater space beneath the lower tube wall. The tubes are arranged in U-shaped bundles with inlet and outlet connections. (D.C.C.)

20958 SECTIONAL SUPPORT GRID FOR INTERMITTENTLY NECKED-DOWN FUEL PINS. Warberg, Henrik S.; McClure, Vernon V. (to Atomic Power Development Associates, Inc.). U. S. Patent 3,350,276. Oct. 31, 1967. Filed Oct. 7, 1965.

The description of a reactor fuel assembly which consists of a wrapper tube, a plurality of elongated fuel rods disposed in the wrapper tube, and a grid assembly is presented. The grid assembly consists of multiple interconnected support rings which surround the fuel rods in parallel arrangement. The fuel rods are necked-down to a smaller diameter and have the support rings fitted into the necked-down portions. The rings engage the fuel elements by four inwardly directed indentations. (D.C.C.)

20959 NUCLEAR REACTOR CONTROL MECHANISMS. Challender, Ronald Scott (to United Kingdom Atomic Energy Authority). U. S. Patent 3,342,688. Sept. 19, 1967. Priority date Dec. 30, 1964, Great Britain.

The description of a dual-purpose control and safety rod drive mechanism is presented. The drive mechanism includes: a driving member passing through a gland; a restraint member keyed to the driven member which uses fluid pressure to prevent rotation; a fluid pressure piston in cam engagement with the restraint member; and a releasable mechanical coupling between the driven member and a control rod carrier on the other side of the gland. Rotation restraint in the control rod carrier is achieved by use of a spring. (D.C.C.)

20960 SUPPORT FOR NUCLEAR REACTOR FUEL ELEMENTS. Gauthron, Maurice (to Commissariat a l'Energie Atomique). U. S. Patent 3,342,440. Sept. 19, 1967. Priority date July 7, 1964, France.

The description of a fuel element support structure is presented. The support structure consists of an annular sleeve, a three-arm extension at the end of the sleeve supporting the fuel element, and a graphite seating block in the middle of the three-arm extension support. (D.C.C.)

20961 REACTOR FUEL ASSEMBLY DEVICE. Venier, Dominic A.; Lass, James L. (to General Electric Co.). U. S. Patent 3,350,275. Oct. 31, 1967. Filed Aug. 26, 1965.

The description of a nuclear reactor fuel element spacer device having fuel element support springs that support and minimize the area of contact with the fuel elements is presented. The fuel element support springs are mounted on open lattice divider assemblies that have maximum support strength and minimum parasitic absorption of thermal neutrons. The periphery of the fuel element spacer device is shaped to provide ease of fuel element loading and minimum contact area with the fuel elements. (auth)

20962 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Ackroyd, Ronald Tunstall; Barker, Allan; Mann, John Erskine; Perks, Maurice Arthur (to United Kingdom Atomic Energy Authority). British Patent 1,102,815. Feb. 14, 1968. Filed June 2, 1964.

A reflector for a nuclear reactor includes adjacent radical zones of liquid and solid reflector both extending substantially continuously around the reactor core. The solid reflector is supported in a manner enabling its position radially of the core to be varied with a consequential displacement of the liquid reflector. Due to differences of the neutron scattering across sections of liquid and solid reflector, this arrangement serves to control neutron leakage over the whole radial periphery of the core. (B.L.M.)

20963 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Babcock and Wilcox Ltd.). British Patent 1,102,850. Feb. 14, 1968. Priority date Dec. 22, 1965, Germany.

A nuclear reactor has a core contained within a pressure vessel with an annular space of substantially constant width between the core and pressure vessel. A number of banks of heat exchange tube platens all the same width are contained within the annular space. All the platens in any bank are parallel to each other, and the platens are so arranged that the platens of the central portion of each bank extend across the entire width of the space. One end of each bank extends between the outer boundary of the space and an adjacent bank, and the other end of the bank extends between the inner boundary of the space and the other adjacent bank. (B.L.M.)

20964 IMPROVEMENTS IN OR RELATING TO PRESTRESSED CONCRETE PRESSURE VESSELS. Hosegood, Samuel Brittan; Kinkead, Alfred Norman (to United Kingdom Atomic Energy Authority). British Patent 1,103,260. Feb. 14, 1968. Filed Dec. 6, 1965.

A prestressed concrete pressure vessel for a reactor is substantially cylindrical in form and has holes for the reception of heat exchangers in the prestressed side wall. A peripheral step is formed in the rim of the vessel at the junction of the side wall and an end wall to facilitate prestressing of the end wall in which at least one closeable penetration provides access to the interior of the vessel. The prestressing of the end wall is accomplished at least in part by cables wound peripherally around the reduced diameter portion formed by the peripheral step. (B.L.M.)

20965 MALOGABARITNAYA ZASHCHITA REAKTOROV. (Small Scale Reactor Shielding). Broder, D. L.; Popkov, K. K.; Rubanov, S. M. Moscow, Atomizdat, 1967. 368p.

A comprehensive study is made of small-scale reactor shielding. Biological reactor protection and description of the role of the thermal and total shielding are discussed. The computation methods and data necessary for calculating the neutron source strength and γ-quanta in the active zone and reactor shielding are presented. The actual optimization of biological protection and various methods of determining optimum protection are described. Analysis of thermal and total shieldings, and of the optimization from the point of view of the heavy component in the shielding, also, the role of boron introduced into the shielding, and the efficiency of various blocking layers in the heterogeneous shielding are presented. The table of e^{-x}, $E_1(x)$, $E_2(x)$ functions and the dosage factors of accumulation of scattered γ radiation in homogeneous metal–water shieldings are included. (R.V.J.)

20966 INZHENERNO-FIZICHESKIE VOPROSY YADERNYKH REAKTOROV. (Engineering and Physics Problems in Nuclear Reactors). Yurovoi, L. N. Moscow, Atomizdat, 1966. 156p.

Fourteen articles are included on the problems in nuclear reactor engineering physics. The existence and unitarity of positive solutions for the stationary equation of neutron transport in a medium with stationary nuclei is analyzed in the first article. The variational method for multigroup neutron field synthesis in a multizone reactor, the multigroup calculation of multizone reactor, and calculation of the spatial-angular neutron distribution in plane multilayer systems are discussed in the next three articles. The fifth and sixth articles cover aspects of effective analytical methods for calculating multizone reactors and wave methods for resolving single-group criticality problems. The variability of reactivity as a function of burnup during the initial operation stages of a fast reactor using fuel dilute with inert diluent is analyzed in article seven. The subgroup method and its realization in diffusion approximation, the method for computing asymptotic spectrum relaxation delineation, and transport equations considering delayed neutrons are covered in the articles eight, nine, and ten. Thermal reactor poison removal by pulse method, the influence of heterogeneous media on neutron moderation in Fe and H_2O and Al and H_2O mixtures, and the critical size of slab reactor are discussed in the last three chapter. (R.V.J.)

20967 PRESSURE CONTAINING VESSELS. Mailer, David Wilson (to United Kingdom Atomic Energy Authority). British Patent 1,105,326. Mar. 6, 1968. Filed Dec. 3, 1964.

The description of a pressure vessel is presented. The pressure vessel is designed with a section divided into multiple ports. The port section is held to the pressure vessel by magnetism, and the ports are designed to collapse at pre-selected pressures. (D.C.C.)

20968 NUCLEAR REACTOR INSTALLATIONS. Taylor, Donald Garden (to United Kingdom Atomic Energy Authority). British Patent 1,105,502. Mar. 6, 1968. Filed Apr. 13, 1965.

The cooling pond and storage facility for a nuclear reactor are described. A transfer facility, which is submerged in the pond, receives irradiated fuel assemblies from the reactor service machine and carries the fuel assemblies to a submerged storage area. (D.C.C.)

20969 CONTROL DEVICE FOR NUCLEAR REACTORS. (to Allmanna Svenska Elektriska Aktiebolaget). British Patent 1,103,878. Feb. 21, 1968. Priority date July 2, 1964, Sweden.

The control device for a nuclear reactor is described. The control rod is enclosed in a cylinder and piston assembly and is supported by a pressurized fluid. When allowed to fall freely the control element drops with gravity and allows pressure bleeding to equalize both sides of the piston face. Mechanical driving of the control rod is accomplished by a rotatable screw and rotation-locked nut. (D.C.C.)

20970 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to General Dynamics Corp.). British Patent 1,103,669. Feb. 21, 1968. Priority date May 17, 1965, United States.

A method of fuel management for a reactor utilizing a Th–^{233}U breeding cycle for a plurality of fuel cycles. The method consists of charging the reactor core with fuel units of uranium and thorium; operating the reactor for the desired reactivity life of the fuel units; reprocessing the fuel elements to eliminate fission products and to recover bred uranium; and refueling the reactor core with bred uranium, thorium, and make-up plutonium for a subsequent reactor cycle. (D.C.C.)

20971 NUCLEAR REACTORS. Martin, Frederick Samuel (to United Kingdom Atomic Energy Authority). British Patent 1,103,594. Feb. 21, 1968. Filed June 9, 1964.

The description of a nuclear reactor moderator is presented. The moderator consists of two mixed resistances: a hydrogen bearing resistance such as paraffins or terphenyls and a deuterium bearing substance such as heavy water or a deuterided organic compound. (D.C.C.)

20972 FLOW CONTROL SYSTEMS. Cundill, Brian Randall (to English Electric Co., Ltd.). British Patent 1,104,025. Feb. 21, 1968. Filed Feb. 16, 1965.

The description of a reactor cooling system is presented. The cooling system is designed for reactors with multi-channel coolant flow and multi-element fuel assembly. Some of the coolant channels contain gag valves for restricting the coolant flow. The valves are controlled to regulate coolant passage. The gag valves are controlled externally by fluid pressure variations in the coolant loop. (D.C.C.)

20973 IMPROVEMENTS IN OR RELATING TO REACTIVITY CONTROL OF NUCLEAR REACTORS. Martin, Dudley James Victor; Lewis, Robert Alec; Kirtley, William Fairley (to United Kingdom Atomic Energy Authority). British Patent 1,103,721. Feb. 21, 1968. Filed Apr. 16, 1964.

The description of a reactor control and shut-down systems is presented. The system consists of a liquid neutron absorber which is mechanically pumped from a reservoir outside the reactor core to a receiver within the core. The mechanical pump consists of a first and a second piston with the first piston adapted for variable displacement operation for reactor control. The second piston is adapted for high speed injection operation for reactor shut-down and is gas-driven. The neutron absorber used is either a solution of H_3BO_3 in heavy water or a solution of $CdSO_4$ in heavy water. (D.C.C.)

20974 INSTRUMENT FOR MEASURING A NEUTRON FLUX. (to Licentia Patent-Verwaltungs GmbH). British Patent 1,104,858. Mar. 6, 1968. Priority date June 16, 1964, Germany.

The description of a neutron flux measuring instrument consisting of a thermocouple unit is presented. The hot and cold junctions are mounted in a common casing. The hot junction is embedded in ^{10}B substance of a ^{235}U substance. The cold junction is mounted in a neutron-insensitive substance. (D.C.C.)

GENERAL

20975 (BMwF-FBK-67-89) KERNFORSCHUNG JAHRESBERICHT 1966. (Nuclear Research Annual Report, 1966). (Mainz Univ. (West Germany). Institut fuer Anorganische Chemie und Kernchemie). Dec. 1967. 121p. (In German). Dep.

Construction and performance of a TRIGA reactor and performance of a Cockcroft–Walton accelerator are discussed. Research in nuclear chemistry and radiochemistry included: separation of fission products, counting techniques, and analysis of data; decay properties of short-lived nuclei; and distribution of mass and charge in the fission of heavy nuclei by thermal and 14-MeV neutrons. Research in analytical chemistry and spectrochemistry is reported. Studies in inorganic preparative chemistry and x-ray analysis are described. (auth)

20976 (COO-825-34) THE TRANSFER OF MAGAZINE TRAINING BY INJECTION OF BRAIN RNA IN RATS. McConnell, James V.; Shigehisa, Tsuyoshi; Salive, Harold (Michigan Univ., Ann Arbor. Mental Health Research Inst.). Dec. 1967. Contract AT(11-1)-825. 20p. Dep. CFSTI.

Food-deprived rats were trained to approach a milk dipper in an operant conditioning chamber in response to a distinct click made by the dipper when it was elevated into the chamber. An RNA extract was prepared from the brains of these animals, as well as from the brains of control animals that had received no such training. The RNA was injected into the brains (subarachnoid space) of naive recipients, who were then required to learn to press either of the two bars in the chamber in order to elevate the dipper and get milk. Recipients injected with RNA from trained donors typically learned the problem within five days. Recipients that received RNA from untrained donors typically did not learn the problem until after five days, if at all. (auth)

20977 (COO-825-35) ATTEMPTS TO TRANSFER APPROACH AND AVOIDANCE RESPONSES BY RNA INJECTIONS IN RATS. McConnell, James V.; Shigehisa, Tsuyoshi; Salive, Harold (Michigan Univ., Ann Arbor. Mental Health Research Inst.). Jan. 1968. Contract AT(11-1)-825. 40p. (CONF-671208-4). Dep. CFSTI.

From 134th Annual Meeting of the American Association for the Advancement of Science, New York.

Three different experimental paradigms were used to study the so-called memory transfer phenomenon. In the first set of studies, donor rats were trained to approach a cup to get a pellet of food when a buzzer sounded. RNA from the brains of these animals was injected intraperitoneally into untrained animals that were subsequently given unreinforced test trials in the same chamber. Recipients that received RNA from trained donors approached the food cup significantly more often than did recipients that received RNA from untrained control donors or that received hydrolyzed RNA from trained donors. In the second paradigm, food-deprived rats were trained to approach a milk dipper in an operant conditioning chamber in response to a distinct click made by the dipper when it was elevated into the chamber. An RNA extract was prepared from the brains of these animals, as well as from the brains of control animals that had received no such training. The RNA was injected into the brains (subarachnoid space) of naive recipients, who were then required to learn to press either of the two bars in the chamber in order to elevate the dipper and get milk. Recipients injected with RNA from trained donors typically learned the problem within five days. Recipients that received RNA from untrained donors or hydrolyzed RNA from trained donors typically did not learn the problem until after five days, if at all. In the third paradigm, donor animals were trained to avoid drinking a saccharin solution by pairing consumption of the saccharin solution with injections of apomorphine hydrochloride. An RNA extract was obtained from the brains of some of the donors and injected into the brains (subarachnoid space) of naive recipients; the homogenized brains of other trained donor animals were put through dialysis, and either the dialysate or the non-dialysable fraction was injected into the peritoneum of naive recipients. Following injection, the consumption of saccharin solution by the recipients was measured. While some statistically significant results were obtained, the magnitude of the transfer effect was considerably smaller than in the first or second paradigm. (auth)

20978 (COO-913-21) PHOTOCHEMISTRY OF BENZENE VAPOR AT 2062A. Gomes, Gilbert (Minnesota Univ., Minneapolis). Mar. 5, 1968. Contract AT(11-1)-913. 16p. Dep. CFSTI.

A study at 2062Å was undertaken to investigate the effect of vibrational energy content on the disappearance quantum yield and the sensitivity of this yield to pressure of foreign gases. The photolysis at 2062Å was qualitatively very similar to the reported photolysis at 1849Å. The disappearance of benzene was linear with time to 25% conversion. Two major products were found: a volatile compound and a polymer. The quantum yield for the disappearance was at all pressures lower than at 1849Å. (M.C.G.)

20979 (COO-913-22) PHOTOCHEMISTRY OF BENZENE IN THE FIRST ABSORPTION BAND. Gomes, Gilbert (Minnesota Univ., Minneapolis). Mar. 5, 1968. Contract AT(11-1)-913. 21p. Dep. CFSTI.

Photochemical studies of benzene at 1849 and 2062Å were extended to 2440Å. The primary objective was to measure the disappearance quantum yield to determine its pressure dependence. At 2537Å no disappearance was found at benzene pressures of 5 and 10 torr. At 2440Å benzene disappeared linearly with absorbed quanta to 3% conversion. The relatively slight pressure dependence of the quantum yield at this wavelength is qualitatively consistent with the fall off of fluorescence at high pressures. (M.C.G.)

20980 (COO-1469-0061) PARTIALLY SEPARABLE FUNCTIONS. Report No. 228. Slivinski, Thomas Andrew (Illinois Univ., Urbana. Dept. of Computer Science). June 1, 1967. Contract AT(11-1)-1469. 111p. Dep. CFSTI.

Thesis.

Threshold logic has been the center of much interest in recent years. This attention has been generated both by demands for logical elements in computer circuits which can perform more complex Boolean operations than AND and OR and by the desire to develop a single unified theory in which the mathematical models for these various logical elements appear as special cases. An extension of the concept of linear separation is presented to generate a wider class of functions. This generalization is affected by modifying the requirements for separation to allow both true and false assignments to reside on the same hyperplane (pseudo-separation) or within the same neighborhood of a hyperplane (marginal separation). Functions which can be separated in either of these ways are called partially separable functions. Some of the theoretical algebraic properties of partially separable functions are investigated and the relationship between these and the corresponding properties for separable functions is explored. Necessary and sufficient conditions for each type of separation are also discussed. A parameter which shows whether a given function is separable, pseudo-separable, or marginally separable is introduced. Integer linear programming algorithms which are guaranteed to minimize the number of true or false assignments on the same hyperplane for pseudo-separation or the number of assignments within the same neighborhood of a hyperplane for marginal separation are presented. A systematic procedure for synthesizing an arbitrary partially separable Boolean function in a network of threshold elements based on these algorithms is developed. (auth)

20981 (COO-1469-0069) AN ANALOG INPUT/OUTPUT SYSTEM FOR THE ILLIAC II. Report No. 246. Otis, Alton Benjamin Jr. (Illinois Univ., Urbana. Dept. of Computer Science). Sept. 22, 1967. Contract AT(11-1)-1469. 72p. Dep. CFSTI.

Thesis.

The facility consists of an audio tape recorder/reproducer, which is the source or receiver of analog signals, and an analog input/output interface that accomplishes both analog-to-digital and digital-to-analog signal transformation. (W.H.K.)

20982 (COO-1498-4) ANNUAL PROGRESS REPORT [ON AMINO ACID ACTIVATING ENZYMES], DECEMBER 14, 1967. (Marquette Univ., Milwaukee, Wis.). Contract AT(11-1)-1498. 12p. Dep. CFSTI.

The long range objectives of this project are characterizing amino acid activating enzymes and determining the chemical basis for recognition of a specific nucleic acid molecule by a specific protein. During the past year progress was made toward these objectives with respect to the arginine and proline enzymes. The arginine enzyme was shown to be activated by its specific tRNA. This was shown to be true also for the glutamine enzyme, that was already known to require its tRNA for catalysis of the ATP-pyrophosphate exchange. The arginine enzyme was shown to catalyze a more rapid reaction with canavanine, an analogue of arginine, than with the normal amino acid, although the Km for the analogue is much higher. The binding of tRNA to the arginine enzyme, as measured by Km, is stronger at acid than alkaline pH. Several other amino acid-activating enzymes examined show similar dependence of Km on pH. The arginine enzyme is protected against heat denaturation by tRNA: the protection is not dependent on the intact RNA molecule, since RNA subjected to

modifications that eliminate enzyme activation retain some ability to protect. The proline enzyme was found to activate certain amino acid analogues with substituents on the pyrrolidine ring. The reversible cold inactivation of the proline enzyme was shown to affect only the transfer of amino acid to tRNA, not the activation step as measured by pyrophosphate exchange. (auth)

20983 (COO-1628-5) ACQUISITION OF IMMUNOLOGIC COMPETENCE BY THE PIG. Myers, Walter L. (Illinois Univ., Urbana. Coll. of Veterinary Medicine). Oct. 2, 1967. Contracts AT(11-1)-1628; Nonr-1834(37). 8p. (CONF-671046-1). Dep. CFSTI.

From Symposium on Factors Producing Embryonic and Fetal Abnormalities, Death, and Abortion in Swine, Chicago, Ill.

Evidence from the literature is presented that immunological competence of pigs is dependent on the presence of preformed antibody. The following conclusions were drawn from the literature survey: the level of competence can be significantly increased by small amounts of passive antibody; this deficiency in natural antibody is normally corrected by passive acquisition of maternal antibody from the colostrum; the level of natural antibody will also increase in the pig by spontaneous de novo synthesis; and in this way the pig will in a few weeks acquire complete immunologic competence. (H.L.W.)

20984 (GEPP-19) ANALYSIS OF THE ELECTRIC FIELD BETWEEN PARALLEL WIRES. Scheid, C. C. (General Electric Co., St. Petersburg, Fla. Pinellas Peninsula Plant). Feb. 16, 1968. Contract AT(29-2)-656. 9p. (R-68-ND-2). Dep. CFSTI.

A description is given of how maximum electric intensity can be determined analytically for the field between two parallel conductors. Analytical results are presented as curves that relate the electric field at the wire surface to a function of wire size and spacing. Various size wires, which had been embedded in Hysol 13-009 epoxy resin, were used to determine breakdown voltage. When relating breakdown voltage to field intensity at the wire surface, all samples tested broke down at a characteristic intensity of approximately 9.9 kv/mil. The calculated maximum field intensity can therefore be used as a design tool in determining optimum wire spacings and maximum allowable voltages. (auth)

20985 (IS-1780) KINETIC STUDY OF THE REDUCTION OF $NbCl_5$ BY NIOBIUM METAL USING A GAS CHROMATOGRAPH. Lorine, D. J.; Stevenson, F. D. (Ames Lab., Iowa). Feb. 1968. Contract W-7405-eng-82. 17p. Dep. CFSTI.

An introductory study of the reduction of $NbCl_5$ by niobium metal in a gas chromatograph demonstrated that the reduction is first order with respect to $NbCl_5$ concentration at temperatures in the vicinity of 500°C. The temperature dependency of the rate constant between 350 and 500°C was also determined. The application of dual column gas chromatographs for reduction studies where no volatile products are formed is demonstrated. (auth)

20986 (K-1729) THE PROGRAMMER'S HANDBOOK. A COMPENDIUM OF NUMERICAL ANALYSIS UTILITY PROGRAMS. Funderlic, R. E. (ed.) (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). Feb. 9, 1968. Contract W-7405-eng-26. 299p. Dep. CFSTI.

A compendium of numerical analysis utility programs is presented. Emphasis was placed on ease of usage, and every effort was made to provide comments on the theory behind each routine, theoretical and practical limitations, and coding information. A bibliography of sixty-two references is included. (B.G.D.)

20987 (K-1735) TERMTRAN: A PROGRAMMING SYSTEM FOR ENGINEERING CALCULATIONS VIA REMOTE TERMINALS. Knight, G. B.; Neu, R. E. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). Feb. 23, 1968. Contract W-7405-eng-26. 53p. Dep. CFSTI.

A programming system for performing a variety of engineering and scientific calculations using a remote terminal is described. The system is designed to be fast, economical and easy-to-learn yet still offer the basic essentials of a programming language. The unique feature of the system is its ability to function in a multiprogramming environment (OS/360) while offering a minimum of interference to other executing tasks. The system has been implemented on the IBM 360/50 and has performed very satisfactorily to date. It is available to any user who has access to the Computing Technology Center's teleprocessing network. (auth)

20988 (K-1737) STUDY OF NON-LINEAR DIRICHLET PROBLEMS. Lick, Dale W.; Tunstall, J. Nelson (Oak Ridge Gaseous Diffusion Plant, Tenn.). Feb. 27, 1968. Contract W-7405-eng-26. 36p. Dep. CFSTI.

The Dirichlet problem $\Delta u = f(u)$, $u \geq 0$, in R, $u = \phi$, on R′, is considered where f is non-linear, R is a bounded domain with boundary R′, ϕ is a nonnegative continuous function, and Δ is the Laplacian operator. The finite difference analogue is analyzed. Iteration methods and numerical calculations are included for the approximate solution with $f(u) = c_1u/(1 + c_2u)$, where c_1 and c_2 are positive constants. Also, the finite difference analogue of the Dirichlet problem $\Delta u = f(u,v)$, $u, v \geq 0$, in R, $\Delta v = g(u,v)$, $u, v \geq 0$, in R, $u = \phi$, $v = \psi$, on R′, is analyzed where ϕ and ψ are nonnegative continuous functions and $f(u,v) = c_1u/(1 + c_2v + c_3u)$ and $g(u,v) = -(c_4u)/(1 + c_2v + c_3u)$, c_1, c_2, c_3, and c_4 being positive constants. Iteration methods and numerical calculations are included for the solution of this problem. (auth)

20989 (LA-3755) THE 1965 ARPA-AEC JOINT LIGHTNING STUDY AT LOS ALAMOS. VOLUME II. THE LIGHTNING SPECTRUM AS MEASURED BY COLLIMATED DETECTORS. ATMOSPHERIC TRANSMISSION. SPECTRAL INTENSITY RADIATED. Barasch, Guy E. (Los Alamos Scientific Lab., N. Mex.). July 1967. Contract W-7405-eng-36. 17p. Dep. CFSTI.

Collimated 50°-field photometers were operated during the 1965 lightning study to obtain data for an analysis of the production of false alarms in air-fluorescence nuclear-explosion detection systems. Detectors were employed in spectral regions useful for air-fluorescence detection: 3914 Å [N_2^+ 1N (0,0)] and 8900 Å [N_2 1P (1,0)], both of which are continuum channels for lightning; and at wavelengths useful for lightning discrimination: 4140 Å [continuum], 6563 Å [Hα], and 8220 Å [NI (2)]. Results from ~870 pulses in 58 flashes, all of which had visible, discrete channels, are presented in terms of source spectral intensities at 3914 Å ($W\,sr^{-1}\,Å^{-1}$) and as ratios of the spectral intensities in other wavelength regions to that at 3914 Å. Distances to the channels, ranging from 3 to 80 km, were measured using a photographic triangulation system, and appropriate inverse-square-law and atmospheric-transmission corrections were made. Observations were made on all types of lightning phenomena: leaders, return strokes, and inter- and intra-cloud processes. The most probable spectral intensity at 3914 Å for all these pulses is 10^4 $W\,sr^{-1}\,Å^{-1}$; values range from 3×10^3 to 10^7 $W\,sr^{-1}\,Å^{-1}$. Average spectral intensities relative to 3914 Å are: 4140 Å, 1.2 ± 0.5; 6563 Å, 2.1 ± 0.8; 8220 Å, 4.8 ± 2.8; and 8900 Å, 0.8 ± 0.4. In first return strokes, the three longest-wavelength signals decrease relative to the 3914-Å signal by a factor of 1.5 to 3. (auth)

20990 (LA-3818) ANALOG PULSE DIVIDER USING FIELD-EFFECT TRANSISTORS. Sutphin, H. Dean (Los Alamos Scientific Lab., N. Mex.). July 2, 1967. Contract W-7405-eng-36. 8p. Dep. CFSTI.

The unique characteristics of field-effect transistors have been used in a circuit design for analog pulse division. The output pulse has an amplitude proportional to the ratio of the amplitudes of two unipolar input pulses. The instrument is capable of handling simultaneous pulses as well as those separated by several microseconds. (auth)

20991 (LA-DC-9286) MORTAR LOCATION BY SHORT BASELINE ACOUSTICAL DETECTION. Ingels, Frank M.; Freyman, Robert W.; Koelle, Alfred R. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 13p. (CONF-680406-1). Dep. CFSTI.

For presentation at IEEE 3rd Regional Conference, New Orleans, La.

Acoustical detection systems utilizing resonant chamber hot wire microphones and large baselines have been in existence since World War I. A new method of acoustical mortar location by utilizing fast response microphones, short baselines, and all solid state data reduction and display is presented. The disadvantages inherent in the older systems were excessive weight (greater than 500 pounds), excessive power requirements, (unable to operate more than one day on batteries), excessive manpower requirements (require three or more operators), and large baselines (greater than 100 feet). The new system weighs less than 75 pounds, will operate two weeks on batteries, requires only one operator, utilizes an eight-foot baseline, and is field portable. Analyses of wind noise, aircraft noise, and mortar shots were made to determine optimum filtering characteristics for reducing noise and enhancing signal detection. Errors introduced by variations in the speed of sound are discussed, and an automatic correction method is presented. System tests were performed with 60 mm and 81 mm mortars at a distance of 2.8 kilometers. (auth)

20992 (NYO-1480-88) A COMPUTER PROGRAM FOR DOING TEDIOUS ALGEBRA (SYMB66). Lapidus, Arnold; Goldstein, Max; Hoffberg, Susan S. (New York Univ., N. Y. AEC Computing and Applied Mathematics Center). Jan. 1968. Contract AT(30-1)-1480. 48p. Dep. CFSTI.

In a previous paper by Lapidus and Goldstein (Comm. ACM 7: 501(1965)) a simple experimental algebraic manipulator which consisted of a set of subroutines for doing elementary algebra

with expressions which were essentially polynomials has been described. A new program (SYMB66) which would include arbitrary functions of one variable and differentiation capabilities as well as a more problem-oriented appearance is presented. (B.G.D.)

20993 (NYO-2598-33) LEACHING OF GIBBERELLIN-LIKE SUBSTANCES FROM THE FOLIAGE OF CHRYSANTHEMUM MORIFOLIUM cv. PRINCESS ANNE. Kozel, Philip Charles (Cornell Univ., Ithaca, N. Y.). Jan. 1968. Contract AT(30-1)-2598. 117p. Dep. CFSTI.

Thesis.

Results are reported from a study of factors that influence the leaching of endogenous and exogenous gibberellins from the leaves of Chrysanthemum morifolium. A technique was developed to determine if exogenously supplied gibberellin can be leached from plants. It is pointed out that the leaching of endogenous gibberellins may have a significant effect on plant growth and development. (C.H.)

20994 (NYO-3859-2) BIOLOGICAL APPLICATIONS OF MOESSBAUER SPECTROSCOPY. Comprehensive Report, May 1965–February 1968. Epstein, L. M.; Straub, Darel K. (Pittsburgh Univ., Pa. Dept. of Chemistry). Contracts AT(30-1)-3514; AT(30-1)-3859. 17p. Dep. CFSTI.

Synthetic iron complexes were studied by Moessbauer spectroscopy. Well-defined, reproducible, and readily interpretable spectra were obtainable for the octahedral complexes in which iron (III) or iron (II) is bonded to the 4 nitrogen in a porphyrin ring and further bonded to nitrogen atoms in amino molecules above and below the ring. Most of the pentacoordinate complexes displayed severe relaxation effects. For dithiocarbamate complexes, the influence of the ligand at the apex of the square pyramidal structure was demonstrated. The tris dithiocarbamate compounds displayed a surprisingly wide range of magnetic susceptibilities and their quadrupole splitting was quite sensitive to structural variations remote from the coordinating atoms. (M.C.G.)

20995 (ORNL-4231) PROGRAM FOR SELECTING FIRST-LINE FOREMEN. Johnson, G. F. R.; Jaffee, C. L. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 30p. Dep. CFSTI.

The development and use of a technique for the evaluation of managerial or supervisory skills are described. The technique of simulation represents an attempt to replicate the essential aspects of a given situation (in this case the supervisory job) so that the prediction of an individual's likelihood of success on a managerial job will be enhanced. Techniques such as the in-basket exercise, leaderless group discussion and business game are discussed, and the samples of the types of information generated are included as well as their usefulness. (auth)

20996 (ORNL-TM-1229) RELATIONSHIP BETWEEN HOLD-UP AND FLOODING IN A PULSED, SIEVE PLATE EXTRACTION COLUMN. McNamee, Richard James (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 110p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

A method for determining the flooding rate of a pulsed, sieve-plate solvent-extraction column was developed. This method is based on measurement of the dispersed phase holdup as a function of throughput rate and time. Since it is a quantitative technique, the error introduced through the judgment of the observer required in the conventional visual method of determination is eliminated, and less experimental work is required. The basic mathematical model used to describe holdup is $(V_D/x) + (V_C/1-x) = \overline{V}_O (1-x)$, where x is the fractional volume holdup of the dispersed phase, V_C and V_D are the superficial velocities through the column of the continuous and dispersed phases, respectively, and V_O is a "characteristic velocity." Holdup was nearly a linear function of throughput, and the holdup at which flooding begins, actually only 0.4 of the holdup corresponding to maximum flow throughput, as predicted by the model, is independent of pulse frequency. The logarithms of the flow rate at flooding and $\overline{V}_O$ were decreasing linear functions of increasing pulse frequency. (auth)

20997 (ORNL-TM-1973) VARIABLES AFFECTING IN VITRO RUMEN FERMENTATION STUDIES IN FORAGE EVALUATION; AN ANNOTATED BIBLIOGRAPHY. Van Dyne, G. M.; Haug, P. T. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 73p. Dep. CFSTI.

Two hundred and twenty-five abstracts are presented on in vitro rumen fermentation studies performed for the evaluation of the nutrient properties of forage crops consumed by livestock. Emphasis is placed on the role of microorganisms in the digestion of cellulose and proteins in the rumen of cattle and sheep. (C.H.)

20998 (ORO-3628-1) MECHANISMS OF INNATE IMMUNITY. I. THE POLYCATIONIC, ANTIBACTERIAL PROTEINS OF POLYMORPHONUCLEAR LEUKOCYTES LYSOSOMES. Progress Report, March 1–November 30, 1967. Spitznagel, John K. (North Carolina Univ., Chapel Hill). Dec. 13, 1967. Contract AT(40-1)-3628. 5p. Dep. CFSTI.

Separation of lysosomal constituents of polymorphonuclear (PMN) cells was carried out by sucrose density gradient electrophoresis. When various strains of four microorganisms were tested against these resolved components, the components exhibited specificity in their antibacterial activity. The components that inhibited streptococci did not affect Staphylococcus aureus and Proteus vulgaris, and vice versa. Interstrain differences in susceptibility of microorganisms to lysosomal cationic proteins were most evident with strains of Escherichia coli. Amino acid analysis of the lysosomal proteins revealed an unusually high concentration (14%) of cystine and a very high arginine-lysine ratio (34.7). Precipitating antibodies against PMN lysosomes were produced in guinea pigs by injecting lysosomal fractions. Similar preparations of macrophages, spleen cells, liver cells, and kidney cells were used for comparative studies of specificity. It was found that spleen cells and macrophages were more closely related to each other than they were to liver and kidney cells. (H.L.W.)

20999 (RLO-1387-8) RADIOTRACER STUDIES OF BIOSYNTHETIC AND RESPIRATORY PATHWAYS. Final Report, September 1, 1960–October 31, 1967. Wang, C. H. (Oregon State Univ., Corvallis). Oct. 10, 1967. Contract AT(45-1)-1387. 12p. Dep. CFSTI.

GLUCOSE — metabolism in microorganisms, rats, and tomatoes, use of concurrent pathways for
CARBON-14 — yield of carbon dioxide-incorporated, from glucose metabolism
METABOLISM — glucose, in mung beans and yeasts, development of radiorespirometer to determine pathways of
EUMYCOTA — Penicillium digitatum, biosynthesis of ethylene in, effects of chloroacrylate on
ORGANIC ACIDS — biosynthesis of four-carbon, in Pseudomonas fluorescens and tomatoes, use of glucose substrate to determine mechanism of
HEXOSES — metabolism in yeasts, effects of 2-deoxyglucose on (E.R.B.)

21000 (SAN-639-7) FLUIDIC (PURE FLUID) TEMPERATURE SENSOR. Phase I Final Technical Report. Report 25, 212. Halbach, Carl R.; Otsap, Ben A.; Thomas, Richard A. (Astro, Van Nuys, Calif.). Jan. 1967. Contract AT(04-3)-639. 89p. Dep. CFSTI.

A fluidic temperature sensor concept has been demonstrated with heated air using a frequency beating technique and detection network to generate a dc pressure signal proportional to the difference in frequencies. The frequency difference in turn is proportional to the square root of the gas temperature. This temperature sensor is being developed for use in potassium vapor and hot gases for temperatures to 2300°R. A pressure insensitive oscillator with a feedback loop and based on acoustic resonance is used as the temperature sensitive element. Signal strength as well as frequency adjustment has been enhanced with the feedback loop which is coupled to the resonance chamber. The frequency detection network which senses the beat frequency and generates the dc output pressure signal is composed of a low pass filter, a limiter, a pulse generator and square wave generator followed by a signal integration stage. Data for heated air test conditions simulating the frequency range required for potassium vapor applications are presented and discussed. The error in sensed temperature of the fluidic temperature sensor with potassium vapor is projected to be ±1.5%. This includes an analytical error to account for the effects of potassium vapor. (auth)

21001 (SC-CR-67-2864) EXPANDED STUDY OF DATA PROCESSING AND COMPRESSION TECHNIQUES. Bittner, Brenda P.; Browning, I.; Winkless III, N. B. (Thomas Bede Foundation, Los Altos, Calif.). Dec. 1967. Contract AT(29-1)-789; Subcontract 72-3058. 47p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

The development of methods for the retrieval of information which was previously packed into storage by a modified n-tuple storage method is described. Additionally, investigations carried out on indexing and abstracting by computer are discussed. (auth)

21002 (SC-CR-68-3501) ON A NUMERICAL TECHNIQUE FOR ELASTIC WAVE PROPAGATION. Final Report ME-32. Pritchard, Robert S. (New Mexico Univ., Albuquerque. Bureau of Engineering Research). Dec. 1967. Contract AT(29-1)-789. 45p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

A numerical technique is developed to analyze circumferentially symmetric impact of three-dimensional elastic regions. Velocities and displacements are determined, using single-level difference equations which are stable for a reasonable range of parameters. Solutions are presented for two problems in which step discontinuities are introduced initially into the velocity fields. (auth)

21003 (SC-DC-66-1967) THE APPLICATION OF HIGH-SPEED MONORAIL ROCKET SLEDS TO AERODYNAMIC TESTING AT HIGH REYNOLDS NUMBERS. Rigali, D. J.; Feltz, L. V. (Sandia Corp., Albuquerque, N. Mex.). Jan. 1968. Contract AT(29-1)-789. 10p. (CONF-680402-1). Dep. CFSTI.

From AIAA 3rd Aerodynamic Testing Conference, San Francisco, Calif.

The use of a monorail rocket-sled system is detailed and recommended as a method of obtaining aerodynamic data in a regime of high Mach and Reynolds numbers. The aerodynamic and mechanical design of the Sandia rocket sleds is described, and the data collection system discussed in detail. The system has been successfully used by Sandia Laboratory to acquire pressure data on cone-cylinders. These data are compared with data from free-flight rockets, wind-tunnel tests, and computer calculations. A principal advantage of the sled testing method is the high degree of accuracy possible in determining actual test conditions, which include Mach number, static pressure, and static temperature. Exploratory tests indicate that sleds may be used to collect other types of experimental data such as heat-transfer and boundary-layer transition. The high-speed sled testing technique appears to be the most promising method of simulating flight conditions at low altitudes at Mach numbers up to M = 8. To date, excellent data have been obtained at a velocity of 7430 ft/sec (M = 6.53) which to our knowledge is the highest velocity ever attained by a rocket sled. At this speed, and the Holloman Air Force Base track altitude, the Reynolds number was 42×10^6 per ft, and the dynamic pressure, 55,000 lbs/ft^2. (auth)

21004 (SC-DC-67-3210) TRANSIENT RESPONSE OF CYLINDRICAL, SHELL-CORE SYSTEMS. Alzheimer, W. E.; Forrestal, M. J.; Murfin, W. B. (Sandia Corp., Albuquerque, N. Mex.). Jan. 1968. Contract AT(29-1)-789. 9p. (CONF-680407-1). Dep. CFSTI.

From AIAA/ASME 9th Structures, Structural Dynamics, and Materials Conference, Palm Springs, Calif.

A long, cylindrical shell containing an annular, elastic core is subjected to a circumferentially uniform impulse. The analysis considers propagation and reflection of stress waves in the core, and the inner core boundary is specified as a rigid reflector, a free surface, or a support offered by another shell. Formulae in terms of elementary functions are developed for the shell response by extending approximate techniques previously used in problems associated with diverging cylindrical waves. These approximate shell response formulae are compared with numerical, finite difference solutions, and the two agree to within a few percent. Results are presented for a wide range of shell and core parameters, and the results demonstrate that solutions which neglect the inertial effects in the core can significantly overestimate the shell response. (auth)

21005 (SC-DR-67-3003) NORMAL AND ABNORMAL ENVIRONMENTS EXPERIENCED BY CARGO ON A FLATBED TRUCK. Foley, J. T. (Sandia Corp., Albuquerque, N. Mex.). Feb. 1968. Contract AT(29-1)-789. 42p. Dep. CFSTI.

The Environmental Data Analysis (EDA) group at Sandia Corporation was invited by Beech Aircraft personnel to accompany them on an over-the-road test of a flatbed truck. Environmental measurements obtained by the EDA group are presented. (auth)

21006 (SC-M-68-63) TABLE OF GEAR RATIOS, 36.0000 TO 5.1449. Lachance, Robert L.; Rayner, Ralph M. (Sandia Corp., Albuquerque, N. Mex.). Mar. 1968. 174p. Dep. CFSTI.

A series of gear ratios from 36.0000 to 5.1449 was compiled primarily for a three-step transmission filament-winding machine. (auth)

21007 (SC-TM-67-2978) SE90 SCAN CONVERTER STORAGE TUBE. Mock, Cecil R. (Sandia Corp., Albuquerque, N. Mex.). Jan. 1968; Revised Mar. 1968. Contract AT(29-1)-789. 14p. Dep. CFSTI.

The scan converter storage tube in the SE90 waveform digitizer is a dual electron gun type with an electron bombardment induced conductivity (EBIC) target system and a special traveling-wave deflection system for the signal input. The target system uses a semiconductor as the storage layer for increasing the induced conductivity. The principles of operation are outlined. (W.H.K.)

21008 (SC-TM-67-3011) EFFECTS OF HARMONIC DISTORTION ON STABLE LOW-Q OSCILLATORS. Griffith, R. D. (Sandia Corp., Albuquerque, N. Mex.). Feb. 1968. Contract AT-(29-1)-789. 38p. Dep. CFSTI.

The relation between frequency stability, harmonic distortion, and excess gain is derived and compared with experimental data. A figure of merit for the feedback network is derived, and several types of networks are compared, including both lumped and distributed parameter networks. Methods for obtaining improved tolerance to harmonic distortion are discussed. (auth)

21009 (STI/DOC-11(Vol.5)(No.3)) LIST OF BIBLIOGRAPHIES ON NUCLEAR ENERGY. VOL. V, NO. 3. (International Atomic Energy Agency, Vienna (Austria)). 1967. 29p. Dep.

A list of 121 bibliographies published and in preparation on nuclear energy is presented. Bibliographies of physics and mathematics, controlled thermonuclear processes, chemistry, biological sciences, health and safety, geology and mining, materials, engineering, reactors, instruments and accelerators, application of isotopes, waste disposal and processing, and documentation are included. (W.H.K.)

21010 (TID-3745) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Issued or in Progress during the Period January-February 1968. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 11p. DTIE Free.

Eight bibliographies are listed which were issued or in preparation during January-February 1968. A report number index is included. (B.G.D.)

21011 (UCB-34P5-47) THE MECHANISM AND KINETICS OF MINERAL ABSORPTION BY PLANTS. Annual Progress Report, October 1, 1966-September 30, 1967. Jacobson, Louis; Overstreet, Roy (California Univ., Berkeley. Dept. of Soils and Plant Nutrition). July 10, 1967. Contract AT(11-1)-34. 15p. Dep. CFSTI.

Progress is reported on the following studies: uptake of cations by roots of plants in CO_2 and in air; relation between respiration and uptake of potassium ions in barley roots; effects of 2,4-dinitrophenol on roots in CO_2 and in air; effects of inhibition of oxidative phosphorylation on oxygen uptake; effects of CO_2 on streaming in surface cells of root segments; effects of CO_2 on anion uptake by roots; uptake of sodium, potassium, and rubidium by Chlorella pyrenoidosa; effects of hydrogen and calcium ions on loss of potassium ions by tissues of Zea mays; and effects of oxygen on loss of potassium ions by tissues of barley and maize. (H.L.W.)

21012 (UCRL-50379) TESTING THE SURFACE-FOLLOWER WAVE-HEIGHT MEASURING SYSTEM. Stinner, R. J.; Snyder, R. M.; Olsen, K. H. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 18, 1968. Contract W-7405-eng-48. 19p. Dep. CFSTI.

The testing of an advanced system for measuring the height and period of deep-ocean waves is described. An instrumentation buoy containing power supplies and data recording equipment is tethered to a second buoy which was previously anchored in the deep-ocean region of interest. Suspended 965 ft below the instrumentation buoy is a sensor housing, containing a vibrating-wire pressure transducer. By taking advantage of the hydraulic filtering of the shorter periods at the sensor depth, it is possible to measure waves of nominal height (>6 in.) having periods as long as 100 sec. Preliminary results are shown and discussed. (auth)

21013 (UCRL-70902) CERTAIN PROBLEMS IN GRAPHIC DATA PROCESSING. Michael, George A. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 1968. Contract W-7405-eng-48. 16p. (CONF-680106-1). Dep. CFSTI.

From International Conference on System Sciences, Honolulu, Hawaii.

Questions and problems which have been encountered in using computers for graphic data processing are restated and briefly examined. Such questions as user qualifications and the determination of the best computer system for a specific use are reviewed. (W.H.K.)

21014 (UUIP-560) EN FOTOELEKTRISK MIKROKATOR MED MOEJLIGHET TILL SNABBA MAETNINGAR. (A Photoelectric Microcator for Rapid Measurements). Svaerdstroem, Anders (Uppsala Univ. (Sweden). Inst. of Physics). Nov. 1967. 10p. (In Swedish).

A photoelectric microcator is described. It is used to measure changes in position of bodies linearly in three ranges: $\pm 100 \times 10^{-6}$ m, $\pm 30 \times 10^{-6}$ m, and $\pm 10 \times 10^{-6}$ m. (Sweden)

21015 (SC-T-68-1507) TECHNOLOGY OF RAPID OPTICAL SHUTTERS. Ebeling, D.; Fruengel, F.; Suarez, J. F. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Optik, 25: 359-76(1967). 25p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

Generally the application of mechanical shutters for the submillisecond region is limited to apertures of less than 20 mm

dia. For apertures of 20 mm up to 100 mm dia other techniques are to be used. There are described two techniques which principally utilize the explosive deformation of matter to obscure large apertures. Experimental development was undertaken with regard to very high closure speed of large apertures, little energy consumption and simple shutter construction. The first technique is based on the explosive expansion of a metalvapour-cloud generated by an electrical discharge through a wire, the second takes advantage of the magnetic pressure, which is applied to an electrical conductor by a magnetic field. The resulting radial closure speed lies within the 700 to 5000 $msec^{-1}$ range. The according energy is about 200 Wsec for apertures ≤50 mm dia. (auth)

21016 RECENT ADVANCES IN ENGINEERING SCIENCE. VOLUME 1. Proceedings of the Second Technical Meeting of the Society of Engineering Science held at East Lansing, Michigan, November 2–4, 1964. Eringen, A. C. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1967. 875p. $45.00. (CONF-641136-(Vol.1)).

Separate abstracts were prepared for three articles; the remainder were not in scope for NSA. (M.O.W.)

For abstracts of individual papers see: 20005, 20006, and 20100.

21017 FUNDAMENTAL NUCLEAR ENERGY RESEARCH, 1967. A Supplemental Report to the Annual Report to Congress for 1967. Washington, D. C., Atomic Energy Commission, 1968. 389p. $2.50. (TID-24295(Suppl.)). GPO.

A report is presented briefly summarizing some of the more noteworthy advancements currently made in the AEC nuclear research. Many of these advancements are of a purely basic nature some are on exploratory development phase, and a few are at the beneficial application stage. The basic physical research programs, reactor technology programs, and biological, medical, and environmental research are covered. (J.F.P.)